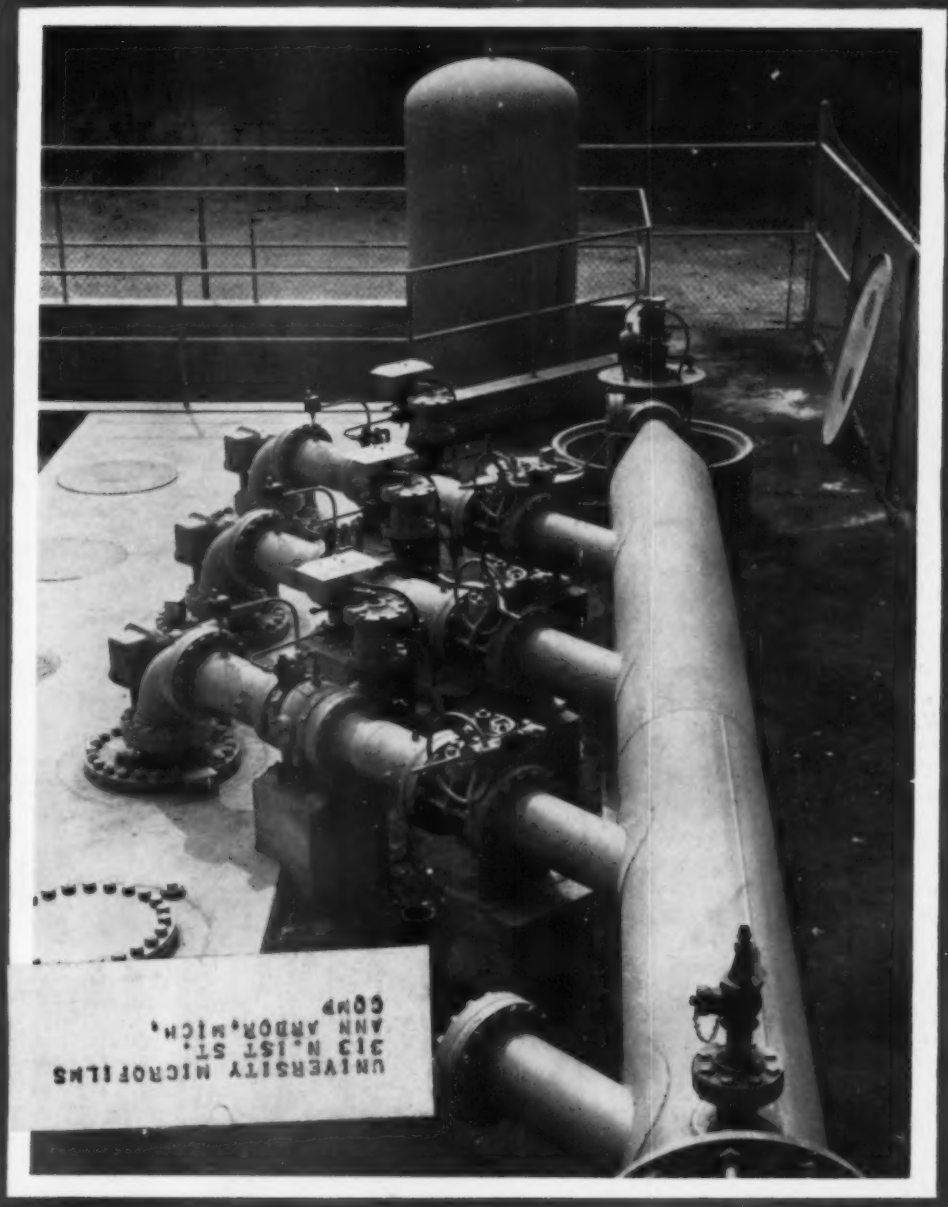
WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

A Scranton Gillette Publication



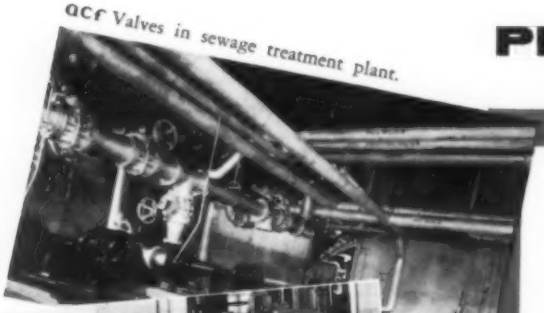
OCTOBER
1957

Submersibles Solve Booster Pumping Problem 431
Sewer Repair by Unique Method 477

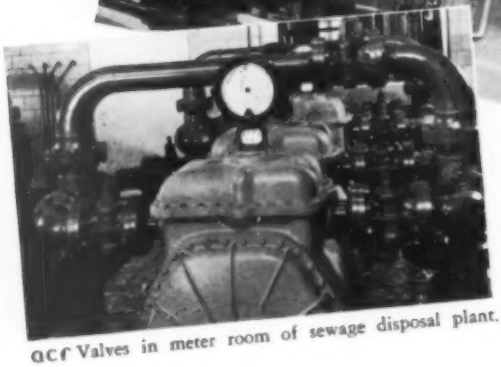
14 reasons why you get superior performance from acf

Be sure to visit our Exhibit, Booths 17 and 18, Statler Hotel, Boston October 7-10

LUBRICATED PLUG VALVES



acf Valves in sewage treatment plant.



acf Valves in meter room of sewage disposal plant.

1. Wide Port—Maximum Flow Efficiency
2. Full Pipe Area
3. Patented Head Gasket made of tough self-lubricating Teflon*
4. Perfectly lubricated (gun or stick)
5. Tight against head leaks under any line pressure
6. Minimum number of parts
7. Lubricant protects against wear and corrosion
8. No exposed seating surfaces
9. Quick opening
10. Installed in any position
11. Compact: fits into small space; gate valve face-to-face dimensions where needed
12. Non-wedging cylindrical plug provides easy operation
13. Easily dismantled for repairs
14. Lubricant release to prevent contamination

*DuPont's tetrafluoroethylene resin.

5704

Study this list of design and operating advantages and you will see why acf Lubricated Plug Valves are meeting the requirements of thousands of plants throughout the nation. acf Valves permit your piping system to handle fluids with maximum efficiency at minimum cost in time, labor and power. Protected seating and sealing surfaces, leak-proof head seal, non-wedging plug reduce "down time" and maintenance to a minimum.

For higher efficiency—longer life—lower cost —specify acf Lubricated Plug Valves.

acf Valves are available in semi-steel, carbon steel, bronze and aluminum.

Sizes: ½" to 24".

Pressures: semi-steel; 175 lbs. WOG to 500 lbs. WOG.

Carbon steel: ASA 150 and ASA 300.

Representatives in all principal cities.

Ask your Industrial or Mill Supply Distributor for acf Valves.

W-K-M

DIVISION OF acf INDUSTRIES INCORPORATED

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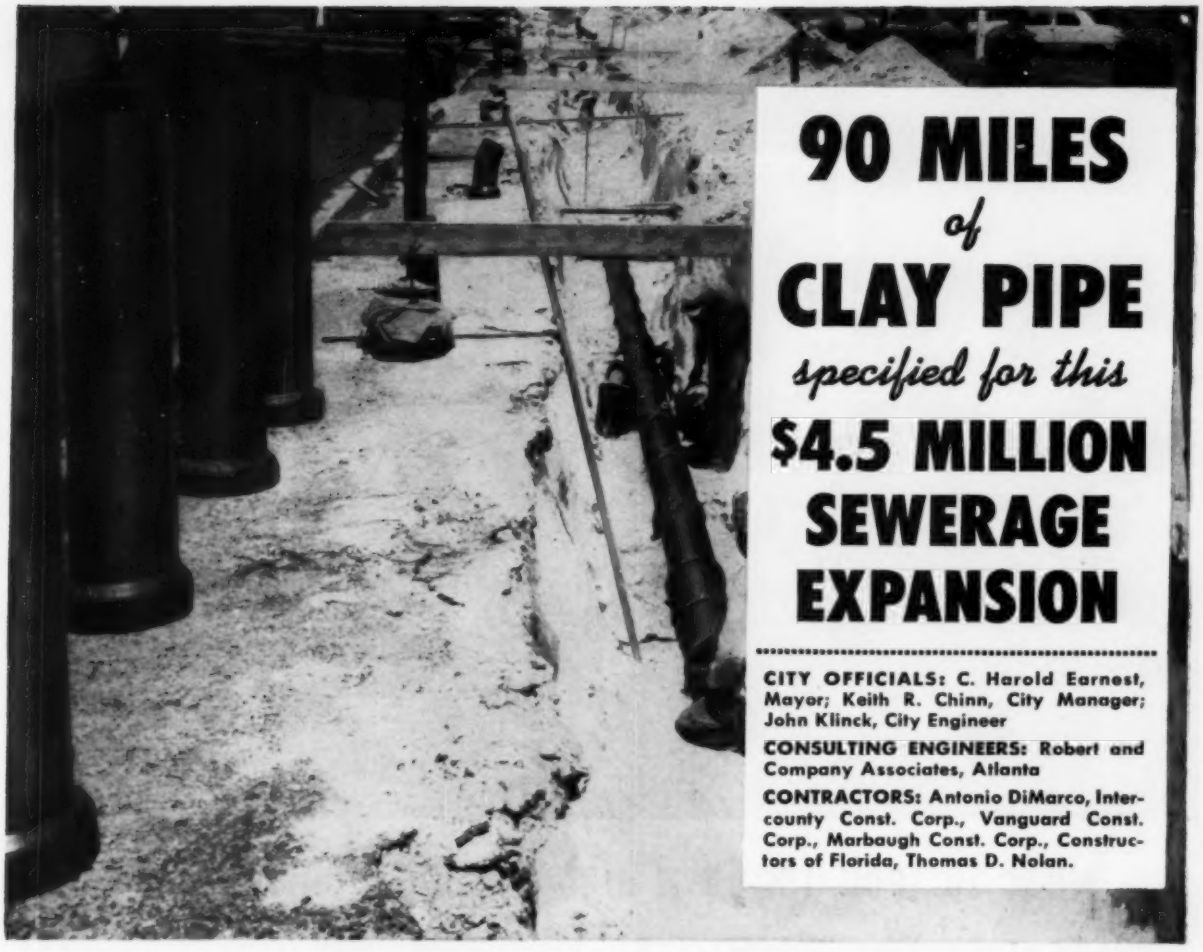
Write Dept. S-10 for new ACF Valve Catalog 400

MANUFACTURERS OF W-K-M GATE VALVES · acf LUBRICATED PLUG VALVES · KEY-KAST ALLOY STEEL PIPING FITTINGS · KEY RETURN BENDS AND FITTINGS



90 MILES *of* CLAY PIPE *specified for this* $4.5 MILLION SEWERAGE EXPANSION

CITY OFFICIALS: C. Harold Earnest, Mayor; Keith R. Chinn, City Manager; John Klinck, City Engineer

CONSULTING ENGINEERS: Robert and Company Associates, Atlanta

CONTRACTORS: Antonio DiMarco, Intercounty Const. Corp., Vanguard Const. Corp., Marbaugh Const. Corp., Constructors of Florida, Thomas D. Nolan.

With ideal climate and a wealth of natural recreation facilities, West Palm Beach, Florida, has become one of the nation's leading resort centers. To accommodate and protect the health of its own citizens, as well as its thousands of yearly visitors, West Palm Beach has embarked on a huge new sewerage expansion and modernization program.

Vitrified Clay Pipe—more than 90 miles of it in 6″ and 24″ diameters—is being installed to serve and protect this city now and far into the future.

Only chemically inert Clay Pipe is completely unaffected by acids and gases. It can't rust, corrode, or disintegrate—is sure to last long after the last bond has been retired. Modern Clay Pipe is longer, stronger and mechanically jointed. When *you* plan sewerage facilities, be sure to specify never-wear-out Clay Pipe. No other pipe offers so many important advantages.

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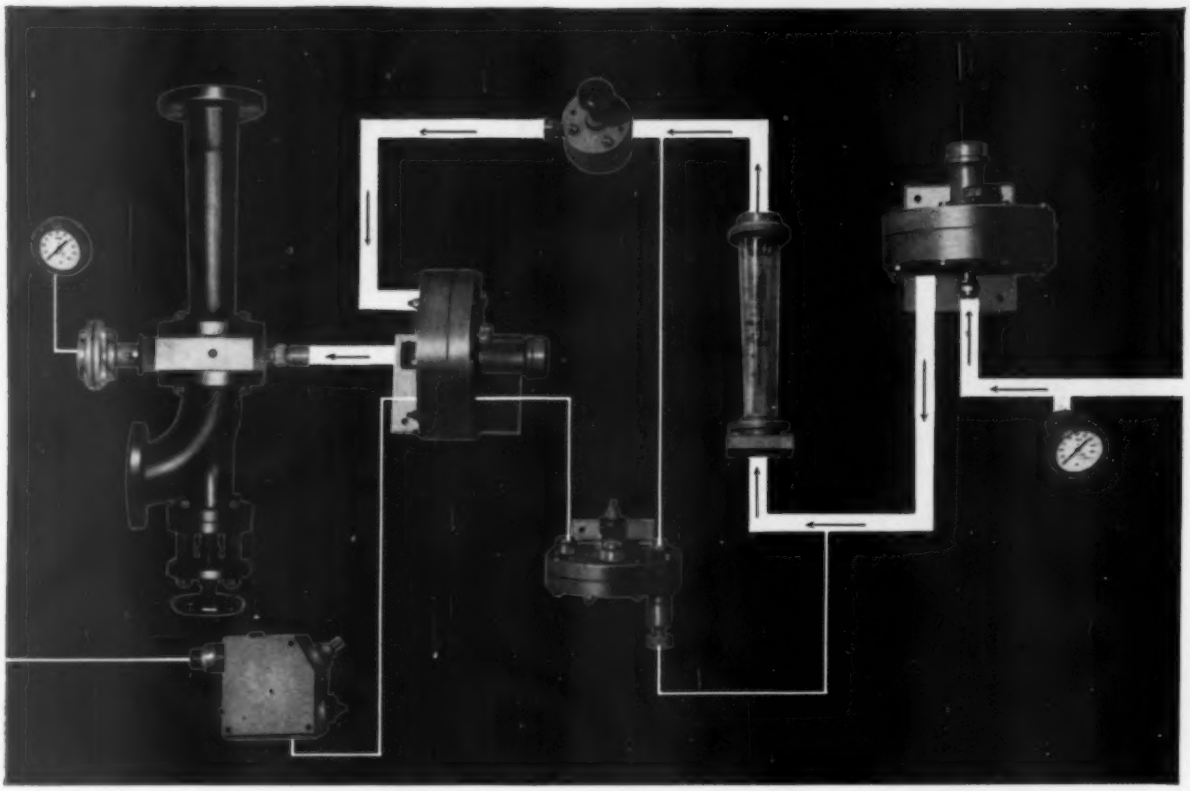
C-871

THE PUBLIC *KNOWS* CLAY PIPE IS BEST

Vitrified CLAY PIPE



what to look for in a high capacity chlorinator

Flexibility . . . corrosion resistance . . . safety . . . low maintenance . . . proved performance . . . *whatever* you're looking for, you can be sure of finding it in Fischer & Porter's Model 1052A. The most imitated chlorinator ever introduced, Model 1052A remains unequalled in every major area of chlorinator performance and economy. Engineered from the ground up by chlorine control experts, it's an outstanding example of design from the *user* point of view.

flexibility matches the job

Model 1052A accommodates flow rates from 30 PPD to 8000 PPD by merely changing the chlorine flowmeter . . . a two minute job. And variable orifice ejector makes operation easy under varying conditions. Models are available for all types of manual, semi-automatic, and automatic operation with or without alarms.

corrosion-resistance for long trouble-free life

Recognized as a triumph in materials engineering, the Model 1052A is fabricated of inert materials throughout. Color is impregnated in the fiber glass plastic cabinet . . . never needs painting or coating. The only metals in contact with chlorine are silver and tantalum. The high pressure inlet tube is solid fine silver, and all other tubing is rigid corrosion-resistant plastic.

safe operation protects plant, personnel, public

System design protects against chlorine leakage, positive pressure conditions, excess vacuum, and flooding . . . eliminates need for hazardous water seals.

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Maintenance, like operation, requires no special skills. Any component can be removed for inspection with a screwdriver, wrench, and pliers in a few minutes. And engineering service is available from forty field offices across the country.

proved performance assures results

Every feature of the Model 1052A has proved itself in years of actual use. Every material used in construction has successfully withstood many years of severe chlorine service. But the best proofs of performance are the thousands of satisfied users of Fischer & Porter Chlorinators throughout the country.

Write now for complete details on the Model 1052A given in Catalog 70-15, available on request . . . and with it, we'll be happy to provide a list of installations. Visit any one of these and you'll see why so many users have found everything they were looking for in a Fischer & Porter Chlorinator. Write Fischer & Porter Company, 207 Fischer Road, Hatboro, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario, Canada.

FP

FISCHER & PORTER CO.

Complete Process Instrumentation

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

Vol. 104 No. 10

OCTOBER, 1957

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CONTENTS

Submersible Pump Applications in Booster Pumping 431
by R. C. Kenmir

How To Maintain Pipe Line Coefficient "C" 440
by Wm. D. Monie and H. B. Scales

Nomograph for Determination of Concentric Orifice Diameters 448
by A. Goldstein

Some Experiences With Plastic Pipe for Water Services 452
by John P. Dowson

Flow in Rectangular Channels 455
by I. E. Livingston

Some Operational Problems of the Small Water Works 456
by Foster S. Burba

New Smryna Beach's Spherical Water Tower 459
by Henry C. Suter

New Sewage Treatment Plant at Petersburg, Va. 460
by T. T. Musgrove, Jr.

Mesophilic Anaerobic Digestion Part I—Fundamentals of Process 464
by L. L. Langford

Method of Handling Dried or Incinerated Sewage Solids 470
by Robert K. Hampton, P.E.

St. Joseph, Mo. Repairs Its Main Sewers 474
by Harry W. Kurtz

Unique Sewer Repair 477
by E. G. Studley and R. L. White

Nomograph for Solubility of Oxygen In Water 478
by D. S. Davis

Meetings Scheduled 102A

New Equipment 110A

Manufacturers' News 118A

Literature & Catalogs 123A

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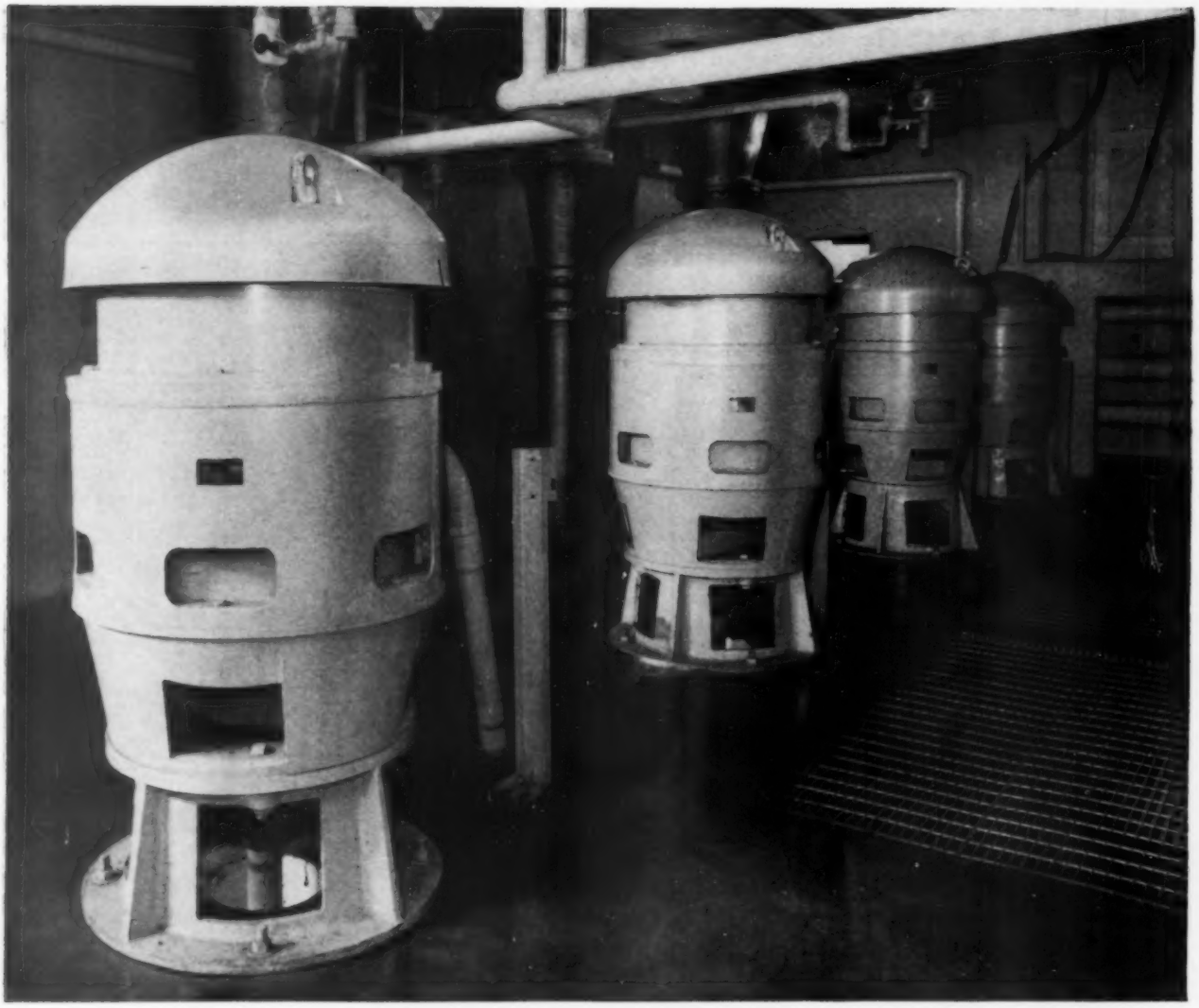
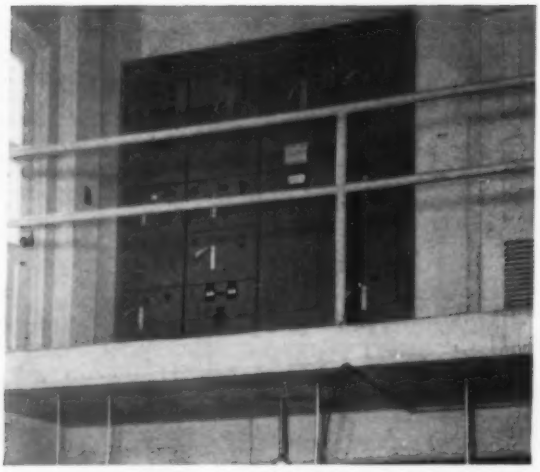
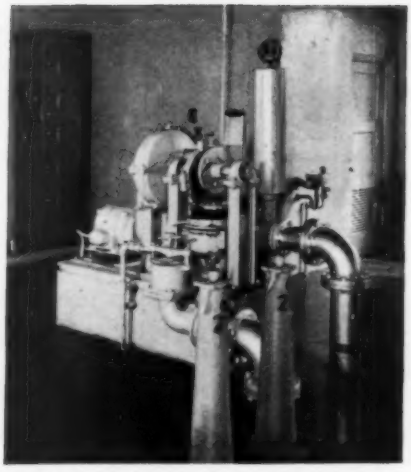




Control center for many of the sewage plant motors, located on a balcony to conserve space, is typical of the Westinghouse unitized equipment which simplifies sewage plant electrical construction.



This Westinghouse motor drives one of the many pumps in the treatment plant. Note convenient location of control unit for this and other adjacent motors.

78 cents per million gallons... pumped by Westinghouse

Basic operating cost of pumping stations in the Tacoma, Washington, sewage plant is of more than usual importance in the over-all plant cost because of an unusually high gallons-per-capita-day flow through the system. Engineers found it necessary to plan for nearly three times normal.

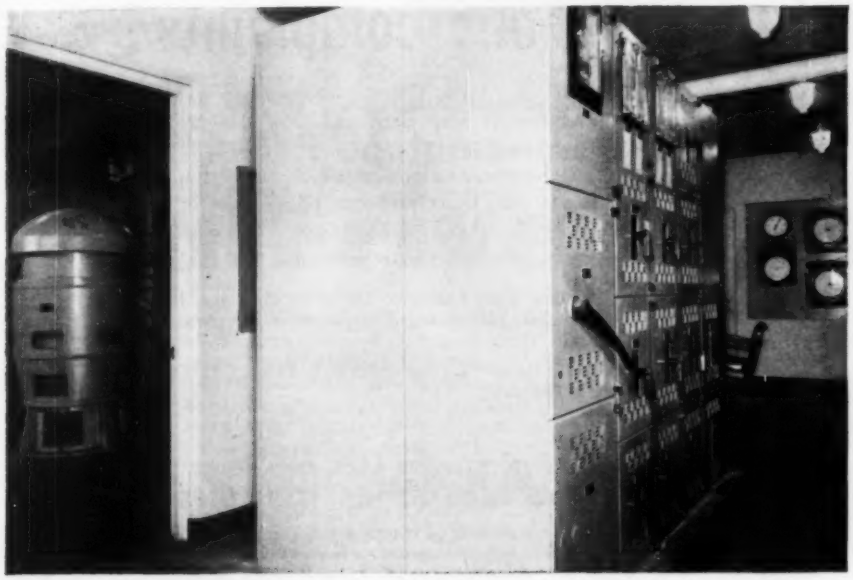
In the main pumping plant at Tacoma, four Westinghouse vertical pump motors handle the load. They are cut in and out as required and the sequence of rotation changed automatically. The station is unmanned except for periodic checks and maintenance by operators from the treatment plant.

Although the pumping requirement is high in proportion to the population served (about 67,000) the actual pumping cost is not. Yearly costs in the Tacoma plant average about 78 cents per million gallons of sewage pumped. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. J-94075

YOU CAN BE SURE...IF IT'S

Westinghouse

The four Westinghouse vertical pump motors in the Tacoma plant—4000 gpm, 50 hp; 8000 gpm, 100 hp; 10,000 gpm, 100 hp; 12,000 gpm, 125 hp.



Distribution of power to motor and lighting circuits for the entire plant is through this Westinghouse switchgear, located in the main pump building.

Are you tired of telephone complaints?

Then follow the lead of one water superintendent who turned complaints into compliments by using Calgon* Threshold Treatment. His telephone continued to ring, but with a difference. Satisfied users wanted to tell him how much they appreciated the clear water supply. No more red water complaints for him.

For Calgon not only stabilizes iron and manganese dissolved in the water at its source, but also prevents iron pickup from pipes . . . and presto! Red Water is stopped. Corrosion control with Calgon† greatly reduces tuberculation, keeps flows high and pumping costs low.

But that's not all . . . Calgon inhibits the formation of lime scale, in either naturally hard or lime softened water. The secret? Scale forming chemicals are kept in solution so filters, valves, mains and heaters stay clean and flow capacities are maintained.

Experienced Calgon engineers put years of experience with water problems of all types in every part of the country at your service. Call on Calgon for help with *your* water problems.

*Calgon is the Registered Trademark of Calgon, Inc. for its glassy phosphate (sodium hexametaphosphate) products.

†Fully licensed for use under U. S. Patent 2,337,856 and 2,304,850.

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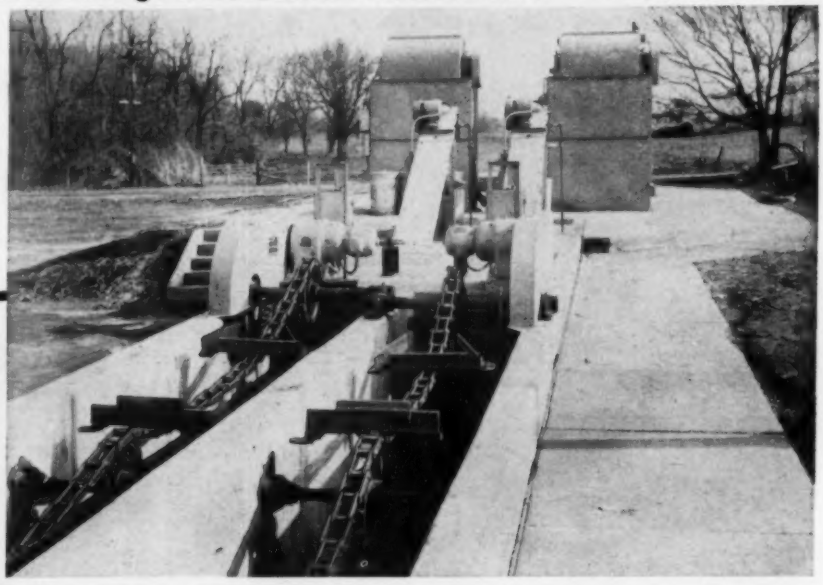
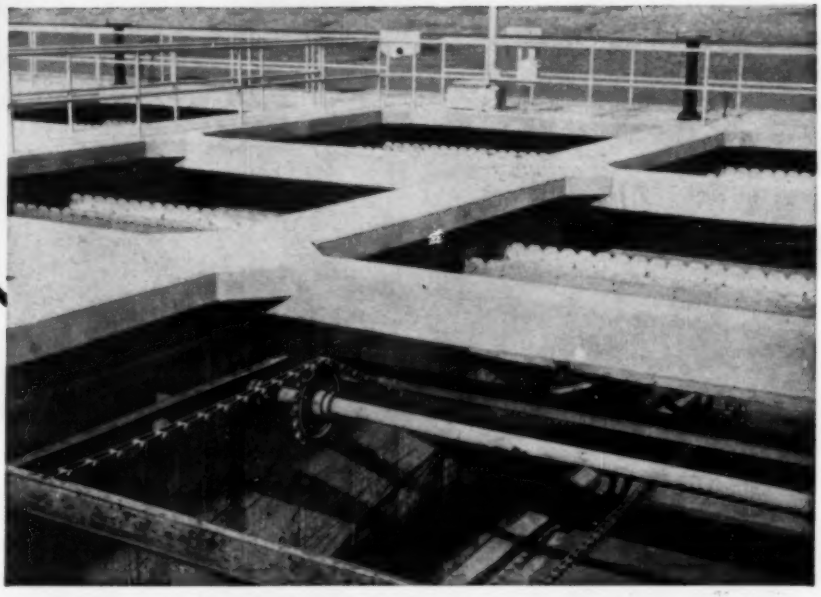
See our exhibit—Federation of Sewage and Industrial Wastes Assns.—Boston, Oct. 6-10



INFLUENT enters parallel channels. Thru-Clean bar screen (background), mounted in each channel, removes trash and debris. Link-Belt roller chain drives each screen through a gearmotor. Inorganic matter such as grit, sand and gravel is removed from the sewage as it passes through the grit chambers (foreground). Each grit collector consists of a strand of 6-in. pitch combination chain with 3/8-in. steel angle flights attached every 5 ft.



EFFLUENT end of settling compartment of pre-aeration settling tanks shows Link-Belt Promal chain and redwood flights used on Link-Belt Straightline longitudinal sludge collectors. Flights, mounted every 10 feet, travel at 2 feet per minute. Flights collect sludge from both settling and pre-aeration compartments. The combination of pre-aeration and settling results in a removal of 70-80 per cent of suspended solids. Weirs at far end of compartment discharge effluent to outfall sewer to river.

How Link-Belt equipment is helping Henderson, Kentucky,

halt river pollution

COOPERATING with the Ohio River Valley Water Sanitation Commission, Henderson, Ky., has recently completed an efficient treatment plant to eliminate dumping of raw sewage into the Ohio River. Consulting engineers were J. Stephen Watkins and Robert E. Martin of Lexington and Louisville.

As in so many other municipalities, Link-Belt equipment was specified for an important share of the work. Units include Thru-Clean mechanically cleaned bar screens . . . Straightline grit collectors . . . grit washing and dewatering screens . . . Straightline longitudinal and cross sludge collectors.

This equipment is part of the broad Link-Belt line. Our sanitary engineers will work with your consultants and chemists—help you get the best in water, sewage or waste treatment.

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You can order it in 100- and 150-lb. cylinders, in multi-unit cars of ton containers, and in tank cars of 16-, 30-, and 55-ton capacity.

Your inquiry will receive our prompt attention.

For safe, efficient, chlorine handling in your plant, write for these two helpful timesavers:

1. *New Hooker chlorine wall chart* lists the most important precautions for handling chlorine; tells what to do in case of accident.

2. *Complete 76-page chlorine manual* gives detailed engineering and safety information. It is fully illustrated with diagrams of equipment for handling chlorine.

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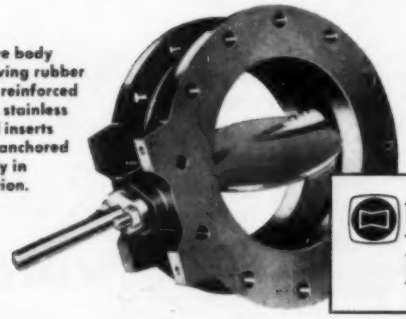
- **Adjustable two-way thrust bearings insure that valve disc is accurately centered.**

If water means money to you, your client, or your community, investigate bubble-tight AWWA Standard Builders Butterfly Valves . . . built by specialists in water and sewage works equipment for these particular services.



Valve body showing rubber seat reinforced with stainless steel inserts and anchored firmly in position.

Request Bulletin 650-L1B which fully describes these and other design features. **Builders - Providence, Inc., 350 Harris Avenue, Providence 1, Rhode Island.**

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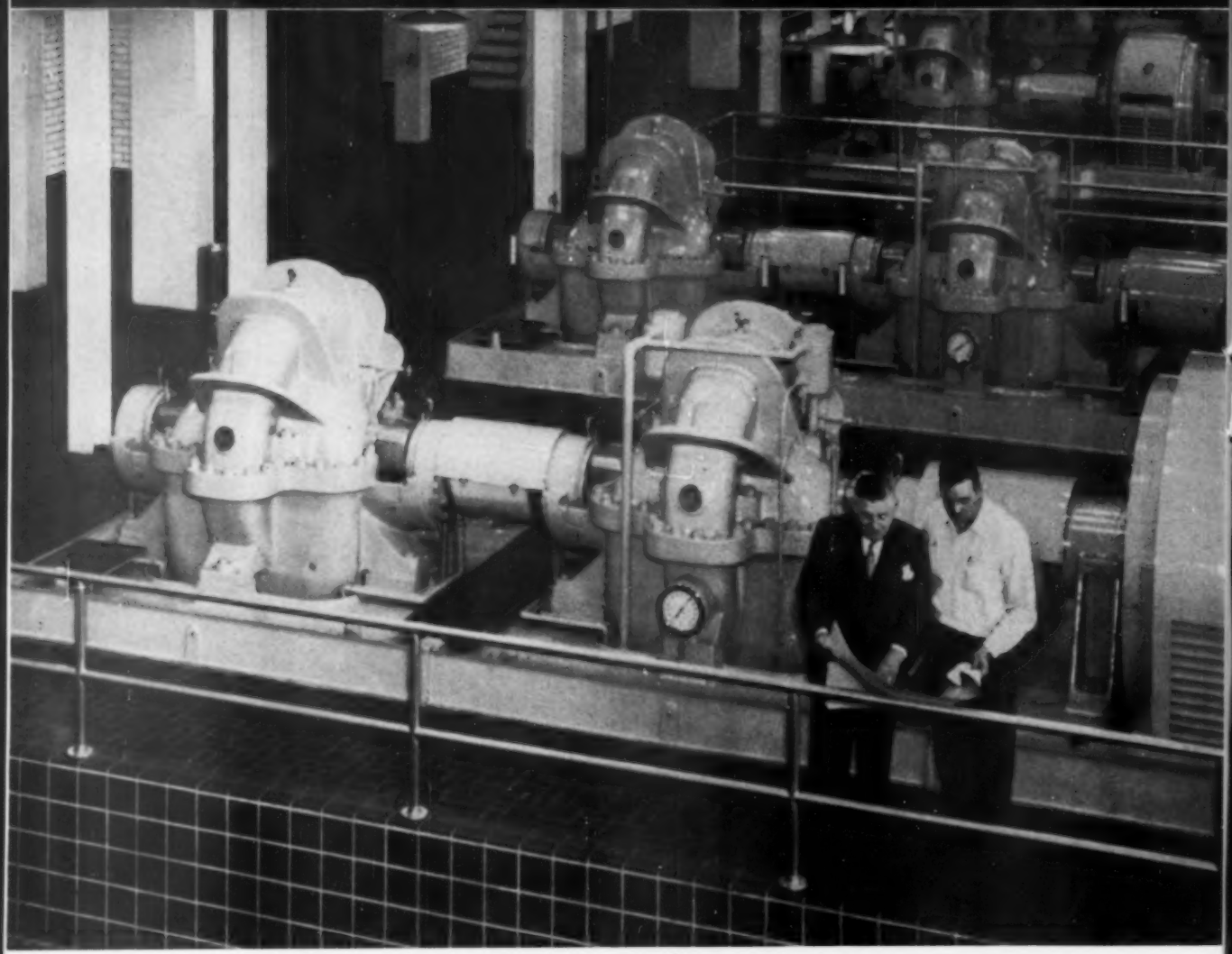

.5 MGD TO 500 MGD

Any size, you have more to choose from with Worthington

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You benefit two ways when you deal with Worthington – world's leading builder of public works equipment.

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Unit responsibility. You do business with one company—eliminating delays and inconvenience that can occur when you are forced to coordinate the efforts of several suppliers. Unit responsibility by Worthington saves you time and money.

Small or large, you'll do better by consulting Worthington. For more information call your nearest Worthington District Office. Or write to Section W-71, Worthington Corporation, Harrison, N. J.

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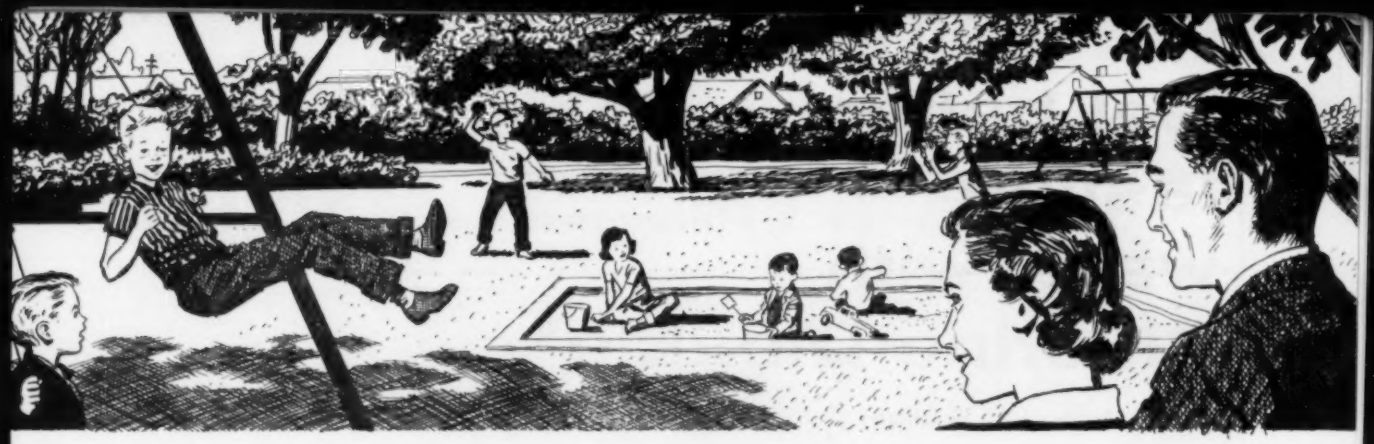

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Totally new aeration plate holders improve any activated sludge process

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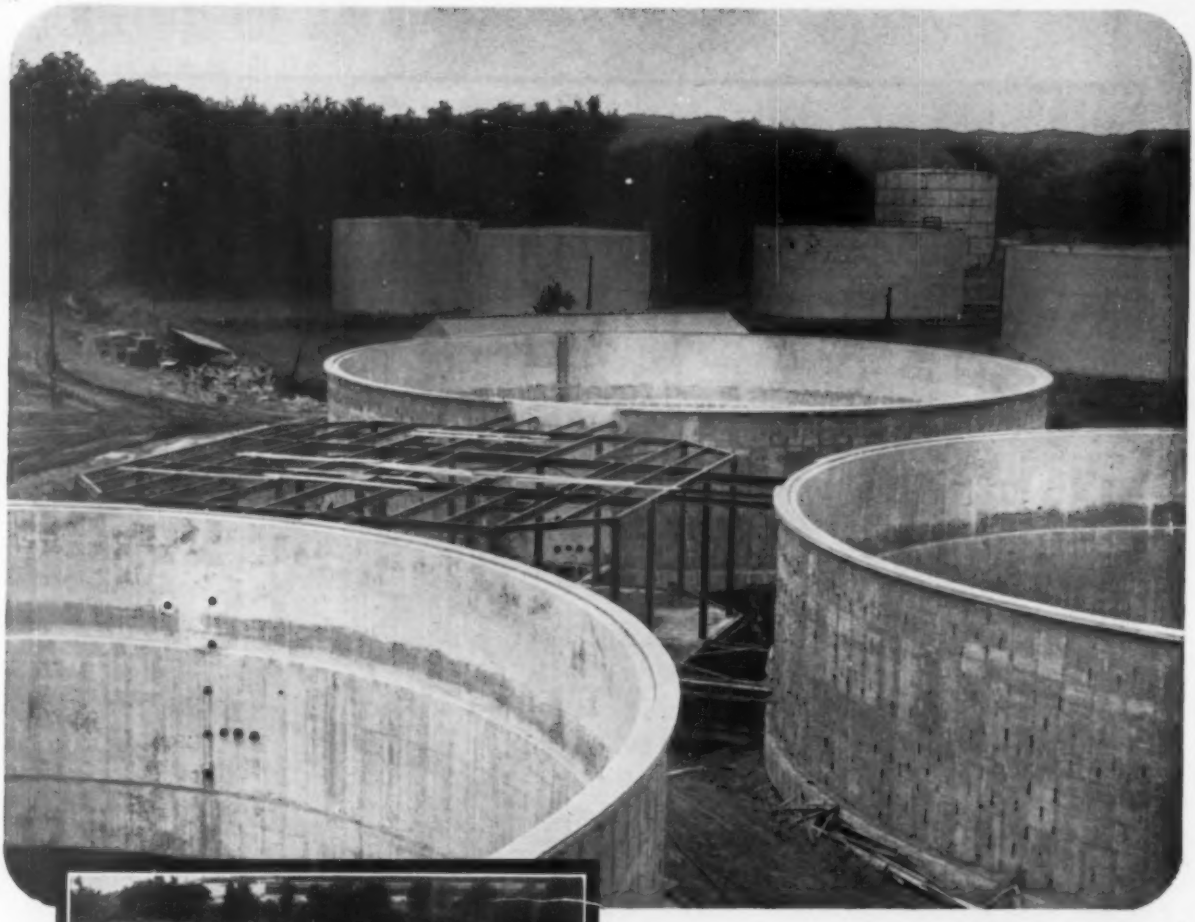
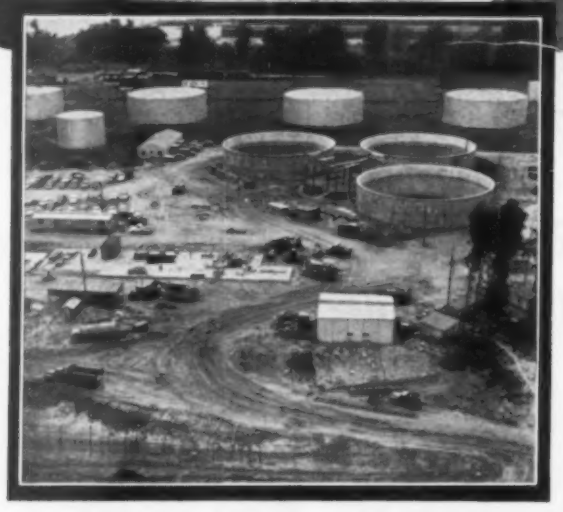




Louisville builds concrete sewage treatment plant *for 1977*

Shown here are views in the construction of the Louisville, Ky., $6 million concrete sewage treatment plant. It is designed for a 100 mgd flow in dry weather and a storm flow of 338 mgd. An expected 40% population increase to 570,000 in 1977 has been taken into consideration.

The plant was designed by Metcalf & Eddy, consulting engineers of Boston and constructed by Gust K. Newburg Co., Chicago.

Concrete is the ideal construction material for sewage treatment plants. It offers: (1) *unusual durability* to resist severe weathering, decay, termites and fire; (2) *great strength* and (3) *real economy* due to moderate first cost, low maintenance cost, long life and low annual cost. Ask for free booklet on financing sewage treatment works. Distributed only in United States and Canada.

PORTLAND CEMENT ASSOCIATION

Dept. A10-29, 33 West Grand Avenue, Chicago 10, Illinois

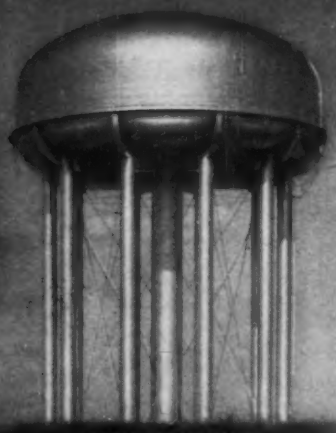
A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work

LANDMARKS— of America's Community Growth

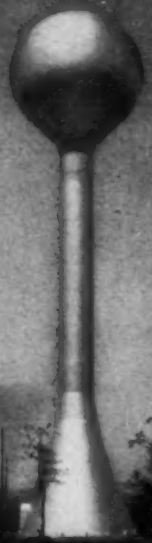
Horton® all-welded structures meet the increasing water storage requirements of growing communities by—

- Reducing pressure variations
- Increasing water pressure
- Providing emergency reserves
- Reducing pumping costs

STANDPIPE



RADIAL-CONE TANK
500,000 to 3,000,000 gals.



WATERSPHERE®
25,000 to 250,000 gals.

WATERSPHEROID®
300,000 to 500,000 gals.

HORTONSPHEROIDAL TANK
1,000,000 to 3,000,000 gals.

ELLIPSOIDAL-BOTTOM TANK
15,000 to 500,000 gals.

RESERVOIR

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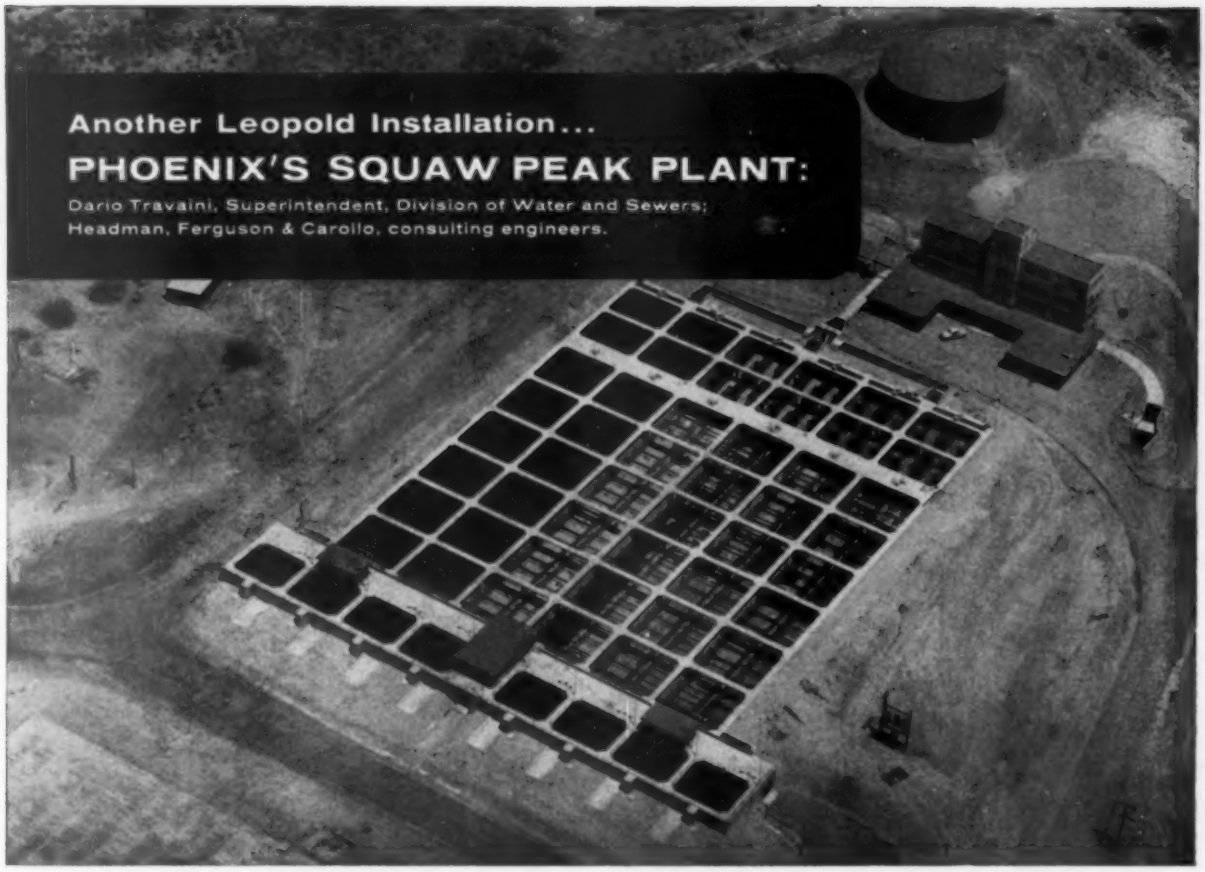
San Francisco • Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

A specific answer to any municipal water storage or pressure distribution problem can be found in the range of capacity and style of structure offered by CB&I in Horton steel tanks. All are built in accordance with AWWA specifications. Write our nearest office for further details.

M42


Another Leopold Installation...
PHOENIX'S SQUAW PEAK PLANT:
Dario Travaini, Superintendent, Division of Water and Sewers;
Headman, Ferguson & Carollo, consulting engineers.

Second Water Filtration Plant for Phoenix, Arizona, also uses **LEOPOLD FILTER BOTTOMS**

To solve the problem of an unusually heavy summertime demand for water, the City of Phoenix constructed, and now has in operation, an additional 30-mgd water filtration plant. Located about ten miles north of the city, this Squaw Peak plant cost over 2¼ million dollars. Although it is presently used only during the summer months, it represents an important step in Phoenix's long range plan of water works improvement and expansion.

For these up-to-date facilities, Leopold glazed tile filter bottoms are being used. They were selected because of their past successful performance in the city's Verde plant—also of 30-mgd capacity.

Whether for new construction or plant modernization, an increasing number of municipalities are installing Leopold water purification and filter plant equipment. And for good reasons, too. We'd like to give you details—without obligation.

Leopold

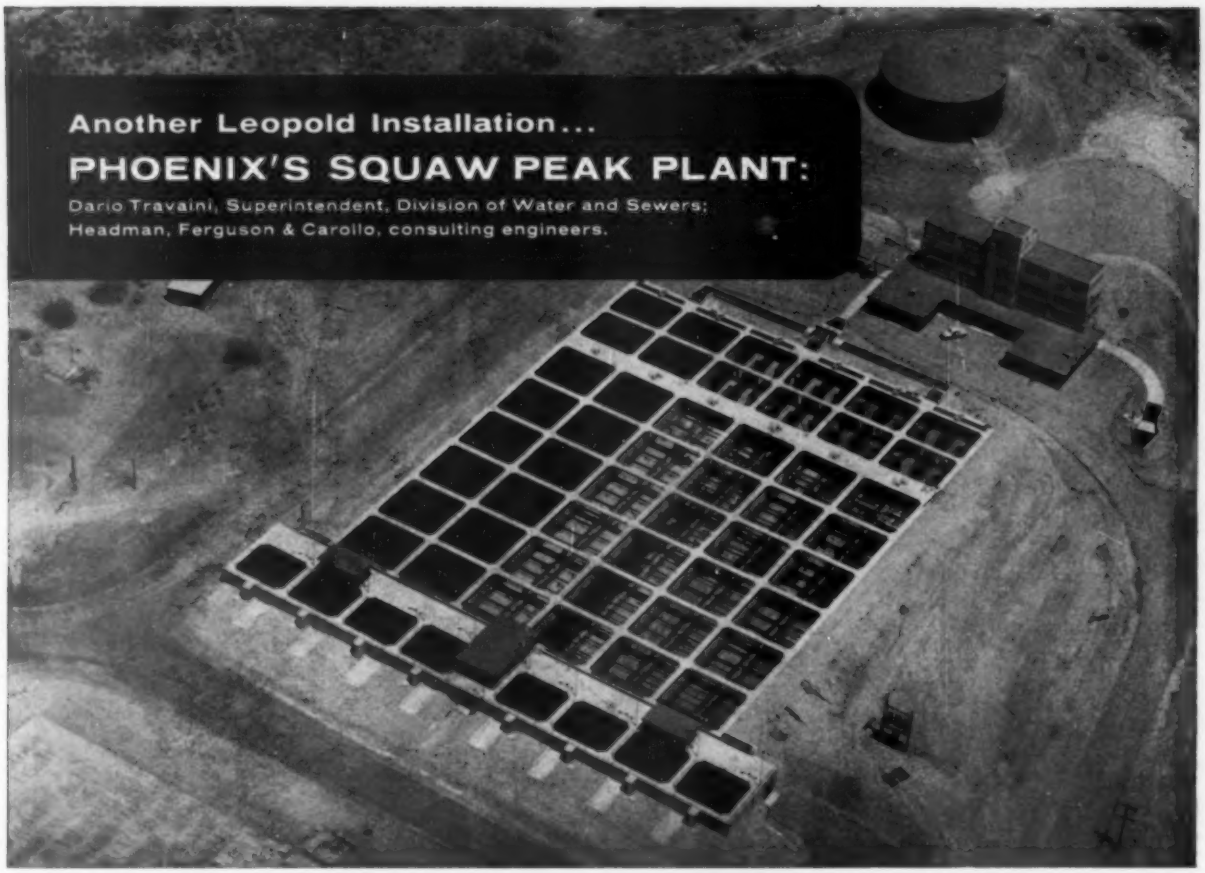
For Top Performance—Use Leopold Bottoms!

F. B. LEOPOLD CO., INC.
ZELIENOPLE, PA.

COMPLETE WATER PURIFICATION AND FILTER PLANT EQUIPMENT · BUTTERFLY VALVES
FILTER OPERATING TABLES · MIXING EQUIPMENT · DRY CHEMICAL FEEDERS
GLAZED TILE FILTER BOTTOMS

DESIGNED, FABRICATED AND ERECTED BY

GRAVER®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GLAZED TILE FILTER BOTTOMS

FILE REFERENCE

FACT SHEET

GRAVER®

Elevated Water Tank for Private Water Company in Suburban Chicago

Victor Yacktman, President
Domestic Utility Services, Co.
Glenview, Ill.
E. N. Fletcher, Consulting Engineer
Des Plaines, Ill.
Graver Tank & Mfg. Co., Inc.
Design, Fabrication and Erection

Type: Double Ellipsoidal Elevated Tank
Capacity: 100,000 gallons
Height of Overflow: 123' 9"
Low Water Level: 100' 0"
Diameter of Tank: 28' 0"
Built to AWWA Specifications
Aircraft warning painting and warning lights in accordance with CAA Regulations
Sterilized and Cathodic Protected

THE PROBLEM

The population growth in greater Chicago made a four square mile unincorporated area in nearby northwestern Cook County a desirable residential development location. The area lay dormant for years because of the lack of water. Long-rooted surrounding communities, which draw water from Lake Michigan, could not handle the needs of a potential 4,000 homes. Located on a fault, the area had shown no promise after numerous attempts to drill productive wells. If the immediate market opportunity for development of the area was to be met, a dependable source of quality water would have to be located and a private utility organized to supply the water.

THE SOLUTION

As the result of studies by Mr. Victor Yacktman, president of the recently formed Domestic Utility Services, Co., a national authority was hired and water of sufficient quality and quantity located. The future of the area assured, several developers joined in the enterprise. Starting with a 12 inch main, seven miles of transmission mains were laid and pumping facilities installed to handle 1 to 1½ million gallons daily.

As the first step in providing water storage and pressure to handle fire protection and all domestic needs including lawn sprinkling, a 100,000 gallon elevated water tank was fabricated and erected by Graver Tank & Mfg. Co., Inc. Valves and butts were installed on the mains for connections with a second elevated tank or standpipe in another location as the area develops.

Graver worked closely with Mr. Yacktman during all planning stages.

Graver's 100 years of experience in tank fabrication and erection can also be valuable to you and your consulting engineering firm. Telephone or write:

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

New York • Philadelphia • Edge Moor, Delaware
Pittsburgh • Detroit • Chicago • Tulsa • Sand Springs, Oklahoma • Houston • New Orleans
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Our 100th Year

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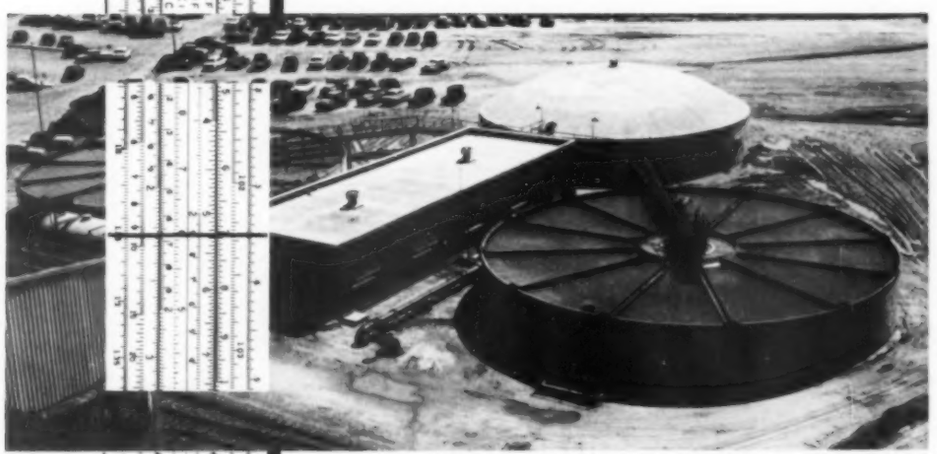
DESIGNED, FABRICATED AND ERECTED BY

ENGINEERED FOR . . .

DEPENDABILITY



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A high-rate, solids-contact water softener and clarifier — proven in hundreds of successful installations.

Write for Reactivator Bulletin WC-103A

Municipal Department: M-411

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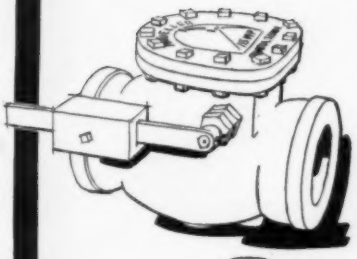
Division of Graver Tank & Mfg. Co., Inc.

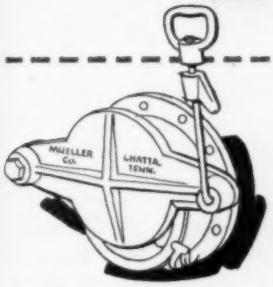
216 West 14th Street, New York 11, N. Y.

MUELLER®
plant valves

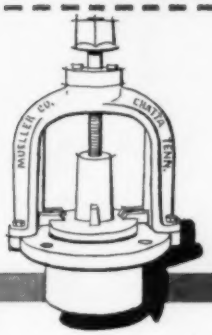
Check Valves For vertical or horizontal position, iron-body, fully bronze-mounted. Hub, flanged or screwed ends. Bronze seat ring with bronze or rubber disc ring. Swing-type; swing-type with lever and weight; or swing-type with lever and spring. 175 p.s.i. working pressure on valves through 12", 150 p.s.i. working pressure on valves 14" through 20". All sizes have 300 p.s.i. test pressure. Underwriters Laboratories and Associated Factory Mutual Laboratories approved also available.

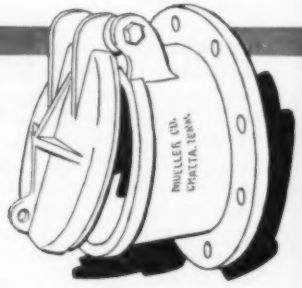


Shear Gates Iron body, bronze seat ring and disc ring. Flanged, hub or spigot frame. Sizes from 4" through 24". Furnished with 2' lift handle and catch. Gate latches 30° below horizontal. This design permits full opening of gate – no obstruction of orifice.



Mud Valves Iron body, bronze disc ring, seat ring and stem. Flanged or spigot frame with non-rising stem – sizes 3" through 24". Flanged or spigot frame with rising stem – sizes 4" through 18". Available with 2" wrench nut, handwheel or extension stem.





Flap Valves
Iron body, bronze seat ring and disc ring. Flanged, hub or spigot frame. Sizes from 4" through 24".

Various types of handwheel and geared floor stands, extension stems, chain and sprocket wheels, stem guides and indicator posts are available for any type of installation.

Consult your Mueller Representative or write direct for complete information.

MUELLER CO. **CHATTANOOGA, TENN.**

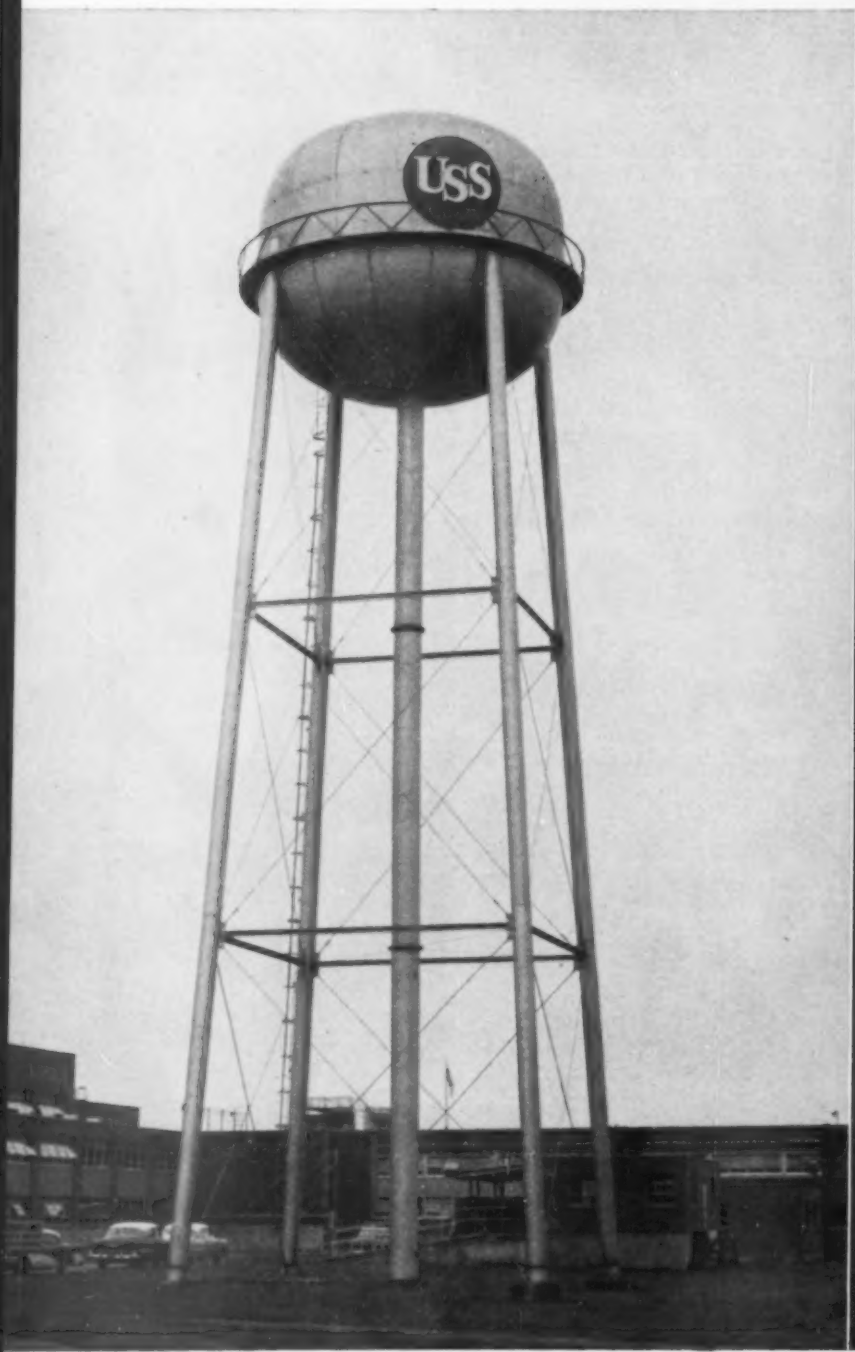
Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

MUELLER CO. 100th YEAR SERVING the Water and Gas Industries QUALITY

Since 1857

FOR UNITED STATES STEEL'S

NEW RESEARCH CENTER AT MONROEVILLE, PA.



Dependable water service and protection

PITTSBURGH -DES MOINES ELEVATED STEEL TANKS

Providing a dependable supply of water at uniform pressure for a wide range of uses found in a great industrial laboratory, this Pittsburgh-Des Moines Elevated Steel Tank also assures ever-ready fire protection for U. S. Steel's extensive central research plant. Of double-ellipsoidal design, the tank is 150,000 gallons in capacity, 34 ft in diameter on a 100 ft tower, and has a headrange of 21 ft 10 in. Write for the descriptive PDM Elevated Tank Catalog, detailing various types and sizes for every water storage requirement.

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NEWARK (2)	218 Industrial Office Bldg.	DALLAS (1)	1223 Praetorian Bldg.
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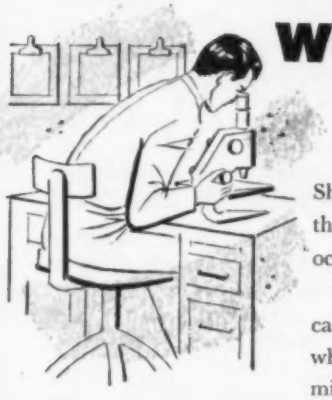
PDM
ELEVATED STEEL TANKS

Microscopic Enemies?

Magnification 800X

Layne Research Defends Your Well Water Supply



Shown here is an actual photograph of one of the many microscopic organisms which may occur in any type water supply.

Layne Research is called upon when well capacity is reduced. Layne Research finds out why. Production records, water analysis and microscopic examinations are some of the methods used to find the reason. Layne Research, thru years of experience in "recovering lost water," selects the correct Laynite material and method to restore well capacity.

IDENTIFY AND PRESCRIBE — that's what Layne Research does for each individual well water problem.

Only Layne Offers Complete Service: *Research* • *Analysis* • *Design* • *Wells* • *Pumps* • *Maintenance* • *Engineering*

1882 — 1957
Layne
75 YEARS OF PROGRESS

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

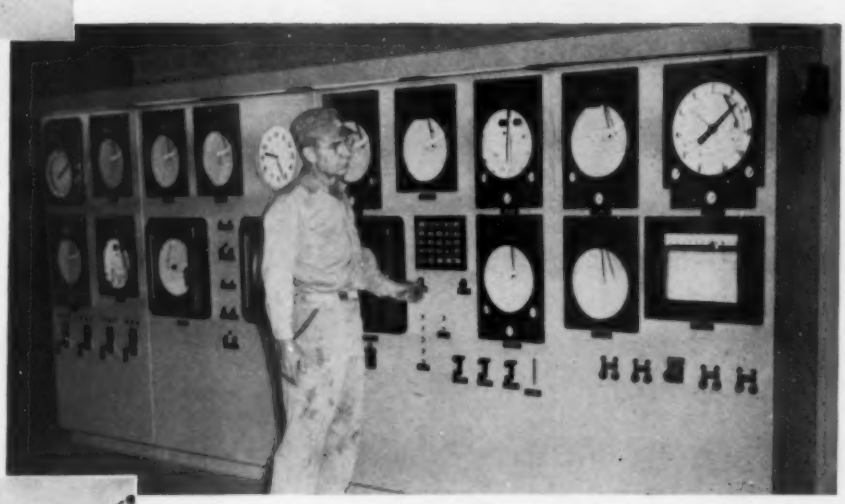
LAYNE & BOWLER, INC. MEMPHIS

General Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

From each *FiltermatiC* console, the operator can choose between *local, automatic,* and *clearwell level-to-effluent cascade control* of filtering rates. He can also start washing by turning a single switch, and control wash rates.

Central control panel provides all data and alarms needed to supervise the Fort Hood Water Treatment Plant. The operator monitors plant operation from this central location without having to inspect individual treating facilities.



Level-to-flow cascade control system maintains a one-inch drop over weirs between the two settling basins so that fine floc will not break up when it falls into the settled water channel.

Fort Hood Water Treatment Plant

saves time and chemicals with FiltermatiC Control System*

ALL key variables at the Fort Hood Water Treatment Plant, near Belton, Texas, are regulated by a Honeywell *FiltermatiC* control system. This automatic, centralized system simplifies plant supervision, saves man-hours. The accuracy of the system in proportioning chlorine, alum and lime from actual flow rates keeps chemical costs down, safeguards plant efficiency.

The plant was designed by Freese, Nichols & Turner, consulting engineers, and built by Merritt, Chapman and Scott, general contractors. Treating facilities consist of raw-water pumping, chlorination, flocculation and sedimentation, rapid-sand filtration and high-lift pumping—all controlled by the *FiltermatiC* system.

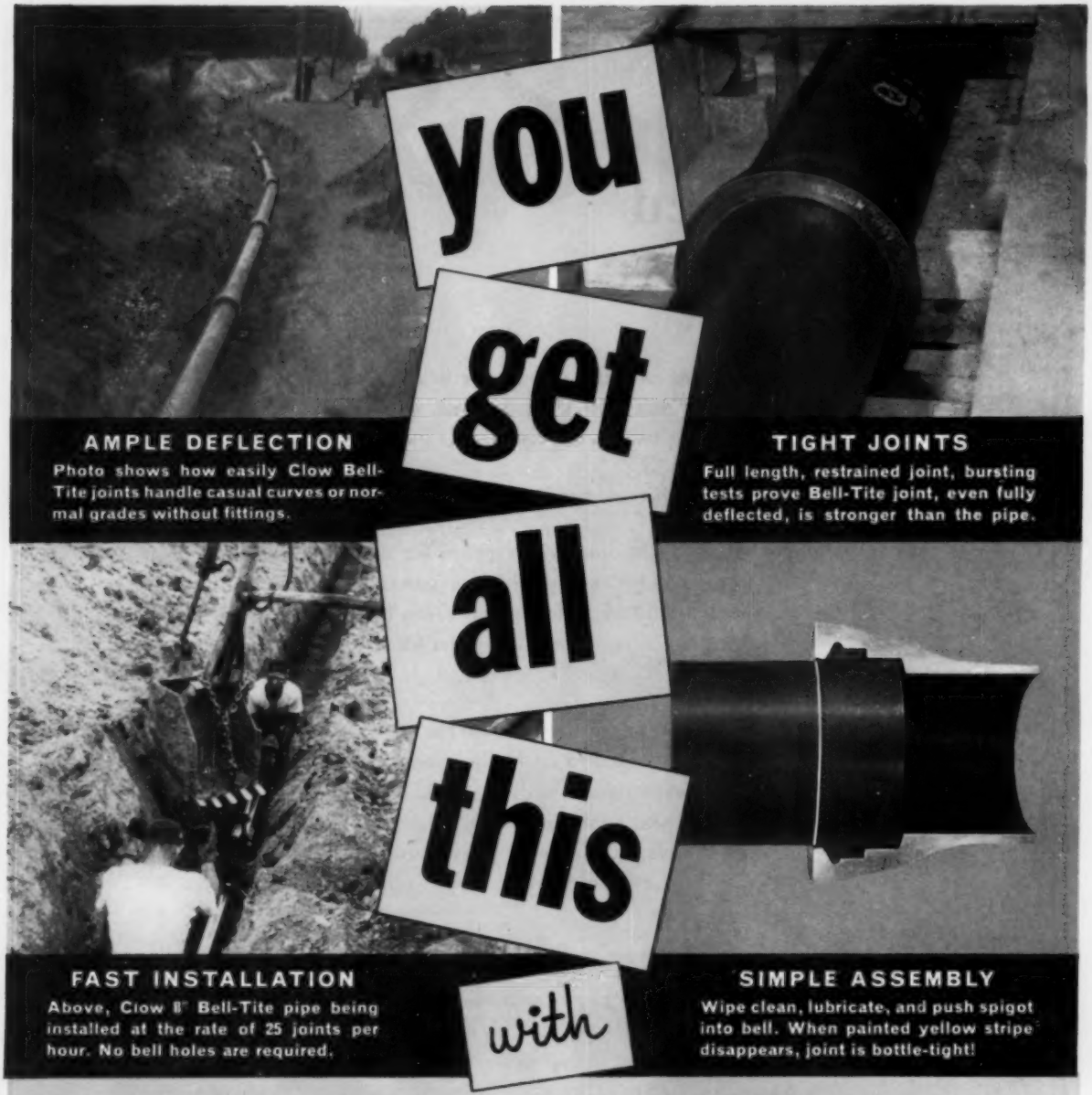
Your nearby Honeywell field engineer can help you gain the many advantages of automatic control in your own plant. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* Wayne and Windrim Avenues, Philadelphia 44, Pa.

*Trademark of Minneapolis-Honeywell Regulator Co.

Honeywell

First in Controls


you
get
all
this
with
AMPLE DEFLECTION
Photo shows how easily Clow Bell-Tite joints handle casual curves or normal grades without fittings.
TIGHT JOINTS
Full length, restrained joint, bursting tests prove Bell-Tite joint, even fully deflected, is stronger than the pipe.
FAST INSTALLATION
Above, Clow 8" Bell-Tite pipe being installed at the rate of 25 joints per hour. No bell holes are required.
SIMPLE ASSEMBLY
Wipe clean, lubricate, and push spigot into bell. When painted yellow stripe disappears, joint is bottle-tight!

CLOW BELL-TITE JOINT*

cast iron pipe

Here's the new time-saving, labor-saving, money-saving way to lay watermain. A single gasket, rubber seal joint that requires no bolts or follower glands to make a tight, dependable joint. Listed by the Underwriters' Laboratories, Inc., for water working pressures up to 350 psi, the pipe itself meets all applicable provisions of AWWA, ASA, and Federal Specifications. Complete details gladly rushed to you on request.

*Patent applied for.

SINCE 1878

JAMES B. CLOW & SONS, Inc.

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Subsidiaries:
Eddy Valve Company, Waterford, New York
Iowa Valve Company, Oskaloosa, Iowa

Continued Progress

BUSINESS continues as usual for us; the heavy pace has not subsided, and our Coilfilter continues to be applied on a relatively nation-wide basis for the dewatering of sanitary sludges.

In reviewing the year's work, three important features stand out vividly.

First, the matter of optimum operating vacuum for dewatering of this class of sludges has been firmly established through research by our own laboratory, and has been determined to be on the order of 12" Hg. Paralleling our work were the efforts of Coackley and others who independently came to the same conclusion.

Second, in the course of equipment development we have reached the position in which we now manufacture all of the specialized auxiliaries for the Coilfilter installations ourselves. This was found to be necessary not only from an operating standpoint but as a point of rendering topnotch service to the Operators of the plants. These auxiliaries involve mainly the chemical feeders and pumps, having design features well in advance of what is available in standard lines.

Third, we are pleased to see repeat orders come to us through the recommendations of our Consulting Engineer friends. Engineers who have chosen our equipment through the years have come to realize the quality of our equipment and service; we note that one office has now used 14 Coilfilters in 8 years. Again, we wish to express our appreciation for the share of work we have been permitted to do during this most successful year.

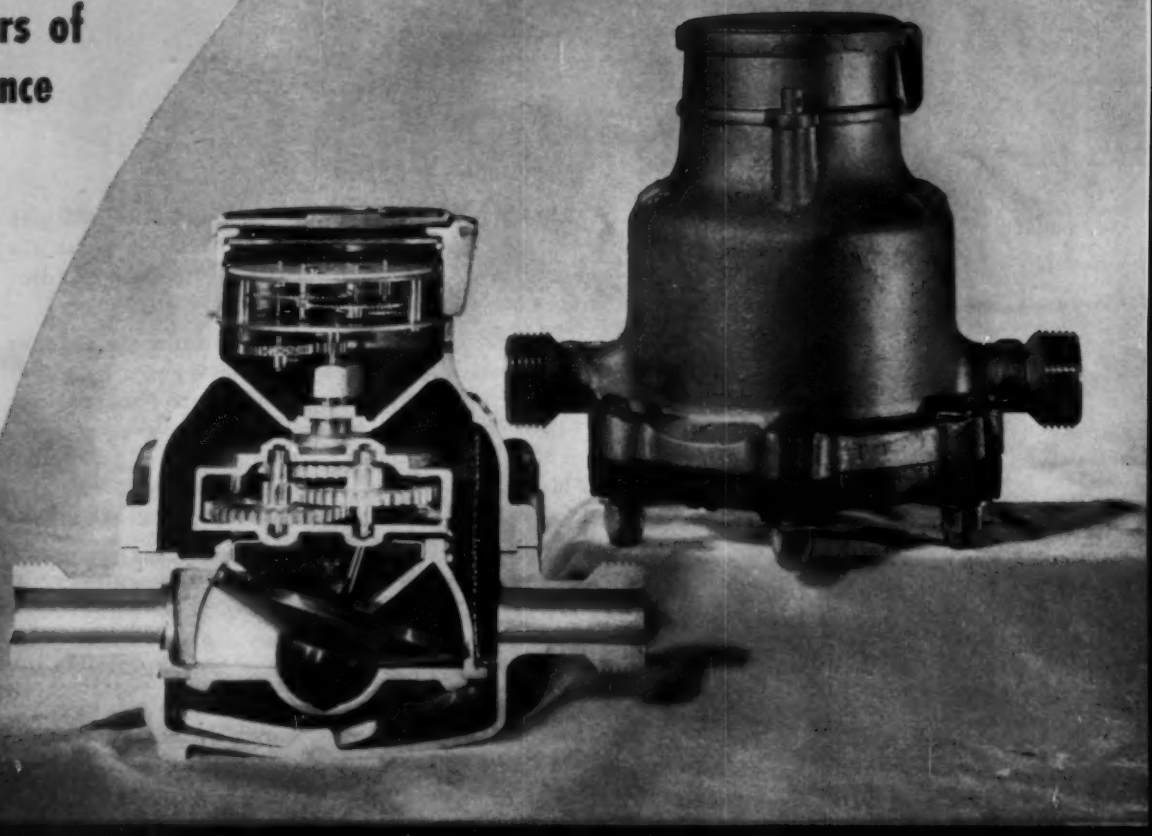
Respectfully,
T. R. Komline

KOMLINE-SANDERSON
ENGINEERING CORPORATION
MANUFACTURERS OF THE COILFILTER
PEAPACK, NEW JERSEY

HERSEY

The Best Water Meter You Can Buy

Because you are buying 72 years of experience



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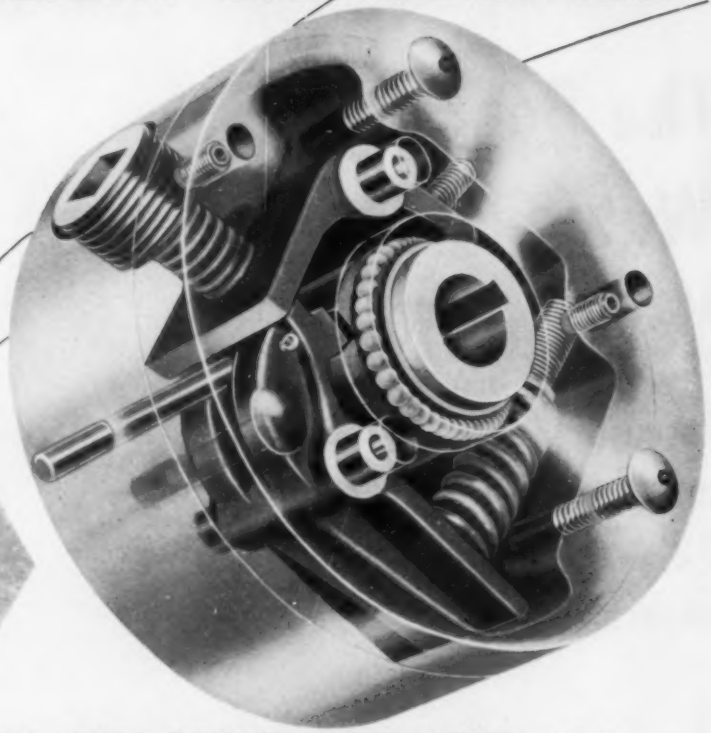
BRANCH OFFICES: NEW YORK — PORTLAND, ORE. — PHILADELPHIA — ATLANTA — DALLAS — CHICAGO
SAN FRANCISCO — LOS ANGELES

Prevent MOTOR DRIVE BREAK-DOWNS BY COLLECTOR FLIGHT BAR CONTROL

- Prevent costly chain breaks
- Eliminate reducer damage
- Avoid need of draining tanks



Use **CENTRIC TRIG-O-MATIC OVERLOAD RELEASE CLUTCHES** with their automatic tripping mechanism which shuts down the entire drive and signals which drive has been overloaded. Avoid costly down time of system to drain tanks due to a break-down of flight bars, reducers and chains.

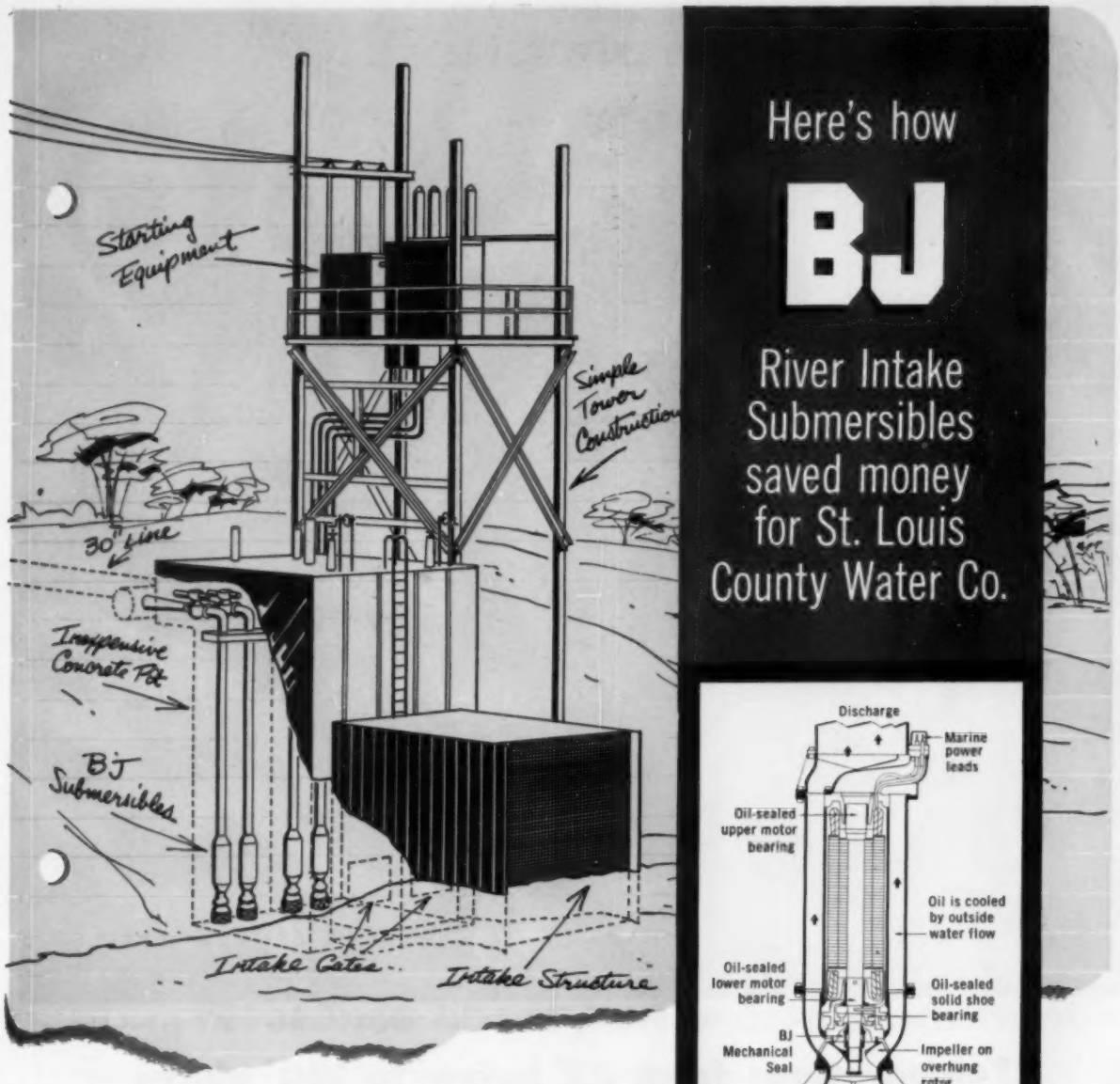
Trig-O-Matic Overload Release Clutches are a tested improvement over any other overload device now in existance. Their precise trigger action gives instantaneous overload protection. Although precision built, the Trig-O Matic clutch is extremely rugged. Each part is amply proportioned and wearing surfaces are hardened to insure extremely long, trouble-free service.
The Centric Trig-O-Matic Overload Release Clutch can easily be installed with flexible couplings (shaft to shaft), sprockets, pulleys, sheaves and gears.

Centrics are mechanical torque limiting devices which automatically trip out at predetermined torque value, when overload occurs. There are no wearing parts. No lubrication is needed. Lock-out design provides complete disengagement. When reset, Trig-O-Matics have the same pre-determined torque value for which the units were initially set and variations in temperature do not have any effect on torque limiting values of the clutch.

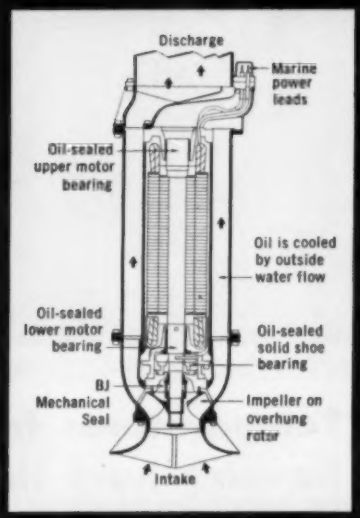
Send for your free Bulletin #304. It completely describes the principle, operation and applications of the Centric Trig-O-Matic Overload Release Clutch.

CENTRIC *Clutch Company*

P. O. BOX 175 • U. S. ROUTE 9 AT MAIN STREET • WOODBRIDGE, N. J.



Here's how BJ River Intake Submersibles saved money for St. Louis County Water Co.



St. Louis County Water Company saved money on their South County Plant installation by using Byron Jackson river intake submersibles. Four completely submerged BJ motor-pump units eliminated the need for an expensive elevated structure to house motors above flood stage. Intake and pump structure are simple concrete pit construction. The only elevated structure is a low cost platform which holds starting equipment.

These BJ Submersibles are unaffected by flood or weather conditions... are always primed and safe from vandalism. The mechanically sealed, oil-filled motor is close-coupled above the pump with all bearings inside the motor housing. No bearings are in the pump itself. Thus no bearings are exposed to silty water. Each pump delivers 3500 GPM against a 100 foot head, and is powered by a 100 HP, 1750 RPM motor. One man, at a remote panel located in the main plant a mile and a half from the river, controls the entire operation.

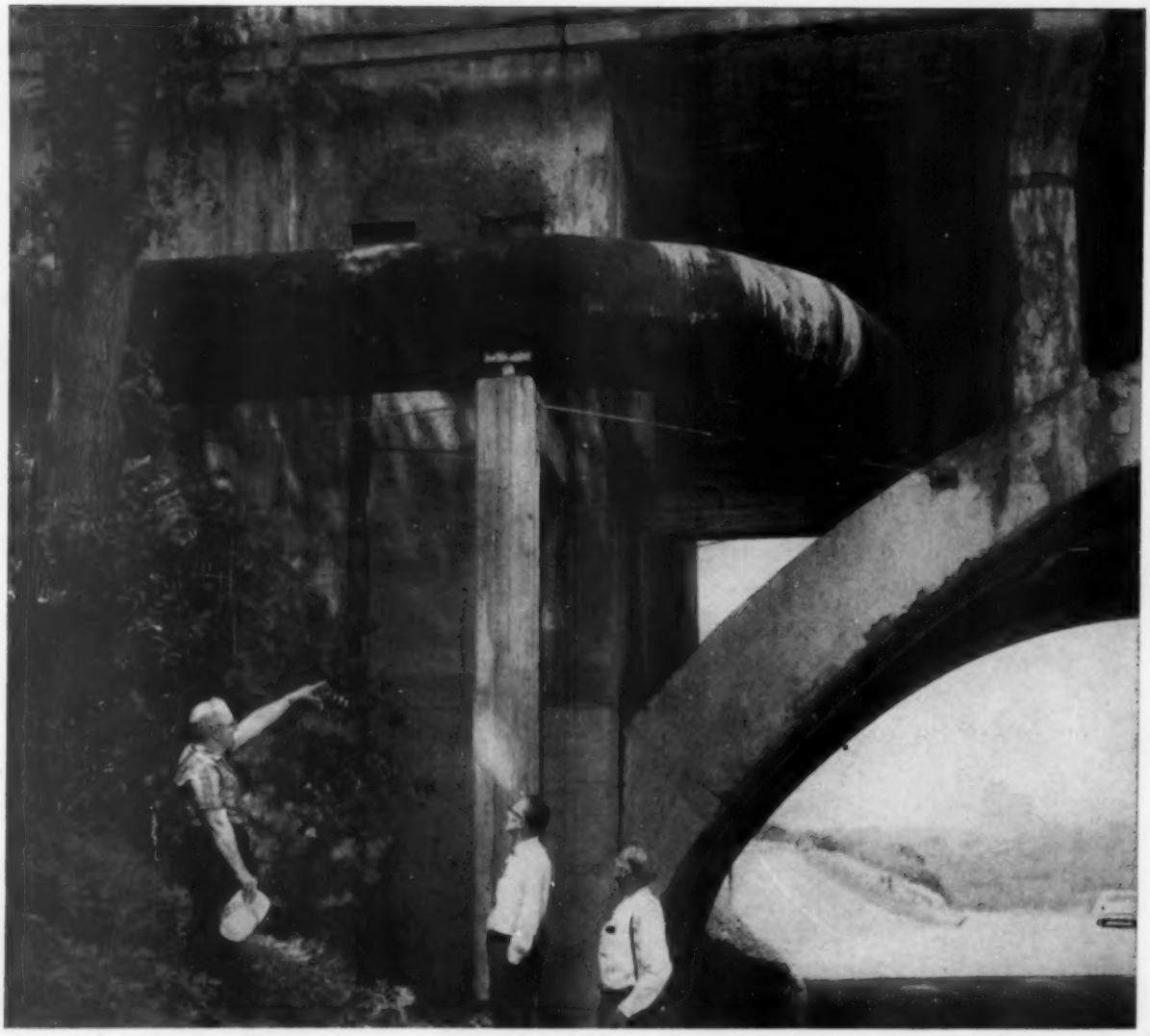
No bearings in the pump!

All bearings are in the sealed, oil-filled motor.

BYRON JACKSON PUMPS
INCORPORATED
A subsidiary of Borg-Warner Corporation
P.O. Box 70 • Lawrenceburg, Indiana

BJ SINCE 1872

Write for complete "Submersible Facts" file including primary, booster and river intake uses.



From left: W. C. Lathrop, Senior Civil Engineer; L. L. Halladay, Waterworks Engineer; C. R. Liese, Senior Civil Engineer—Water Works Dept., Minneapolis

Temperatures from 32° below to 100° above haven't hurt this tar-enameled steel pipe

Here in Minneapolis two long spans of exposed steel pipe have been subjected to a 132-deg temperature range for the last eight years. But despite frigid winter spells down to 32 deg below and scorching, 100-deg summer days, the pipe has functioned perfectly.

The 48-in. ID main shown above extends 837 ft across the Mississippi River cradled under the Franklin Avenue bridge. The pipe was coal-tar enameled inside and out and has no other protection. It was supplied by Bethlehem in 40-ft lengths joined by butt-welding. The pipe rests on rollers to permit movements due to expansion and contraction, but expansion joints were not required.

The river crossing is a small portion of the city's 19.5-mi "Big Inch" water main which was completed in 1949. Bethlehem supplied 102,500 ft of 48 x ⅜-in. tar-enameled steel pipe for the project. It was laid, with welded joints, by the Water Works Department of the City of Minneapolis.

The Water Works Department states that the entire line has given outstanding service. The fact that no leakage or loss of flow has been reported indicates that the interior lining is in excellent condition. Visual inspection has not disclosed any impairment to the pipe coating.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
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The answer to your problem of municipal or industrial pollution, or waste reclamation, may be found in the new Rex Bulletin 315-11. This bulletin describes various methods of waste treatment and the CHAIN Belt quality process equipment available to perform these functions reliably and efficiently.

If your specific problem is sludge or scum removal from rectangular tanks, the new Rex Bulletin 315-61 describes in detail the proved Rex Conveyor Sludge Collectors and Skimming Equipment which will do the job in the best possible way.

You or your engineers will find these two new bulletins helpful in selecting waste treatment equipment.

For data on other Rex products for waste and water treatment, detailed bulletins are available. These bulletins will help you select and specify the proper equipment for the job...equipment designed and built in the CHAIN Belt tradition of quality engineering and manufacture. Many of these bulletins include engineering and selection data.

Complete your "reference library" today. Send the coupon for these new bulletins, or other bulletins, that can help you with your problems of waste treatment.

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Please send the bulletins checked as follows:
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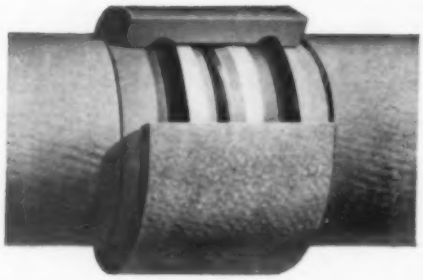
"K&M" ASBESTOS-CEMENT PIPE and exclusive FLUID-TITE Coupling



Exclusive sealing rings are the secret of the "K&M" FLUID-TITE Coupling installed with "K&M" Asbestos Pipe. All "K&M" couplings and pipe are hydrostatic pressure-tested to 3½ times the rated operating pressure!

No need to wait for dry skies or a dry trench before installing "K&M" Asbestos-Cement Pipe. Wherever water is to be piped under pressure, "K&M" Pipe is the modern answer. The exclusive FLUID-TITE® Coupling makes installation quick, easy—and permanent.

No special equipment; little skill needed. Just two easy steps: 1. Lubricate rubber rings; 2. Slide pipe into coupling. It is watertight immediately. The FLUID-TITE Coupling allows deflection up to 5° at each joint. Installation and maintenance costs go down when you specify the *modern* pipe and coupling . . . "K&M."

Meets specifications. "K&M" Pressure Pipe meets A.W.W.A., A.S.T.M., and U.S. Federal Specifications, and has Underwriters' Laboratories approval for all sizes (pipe and couplings) in Class 150.

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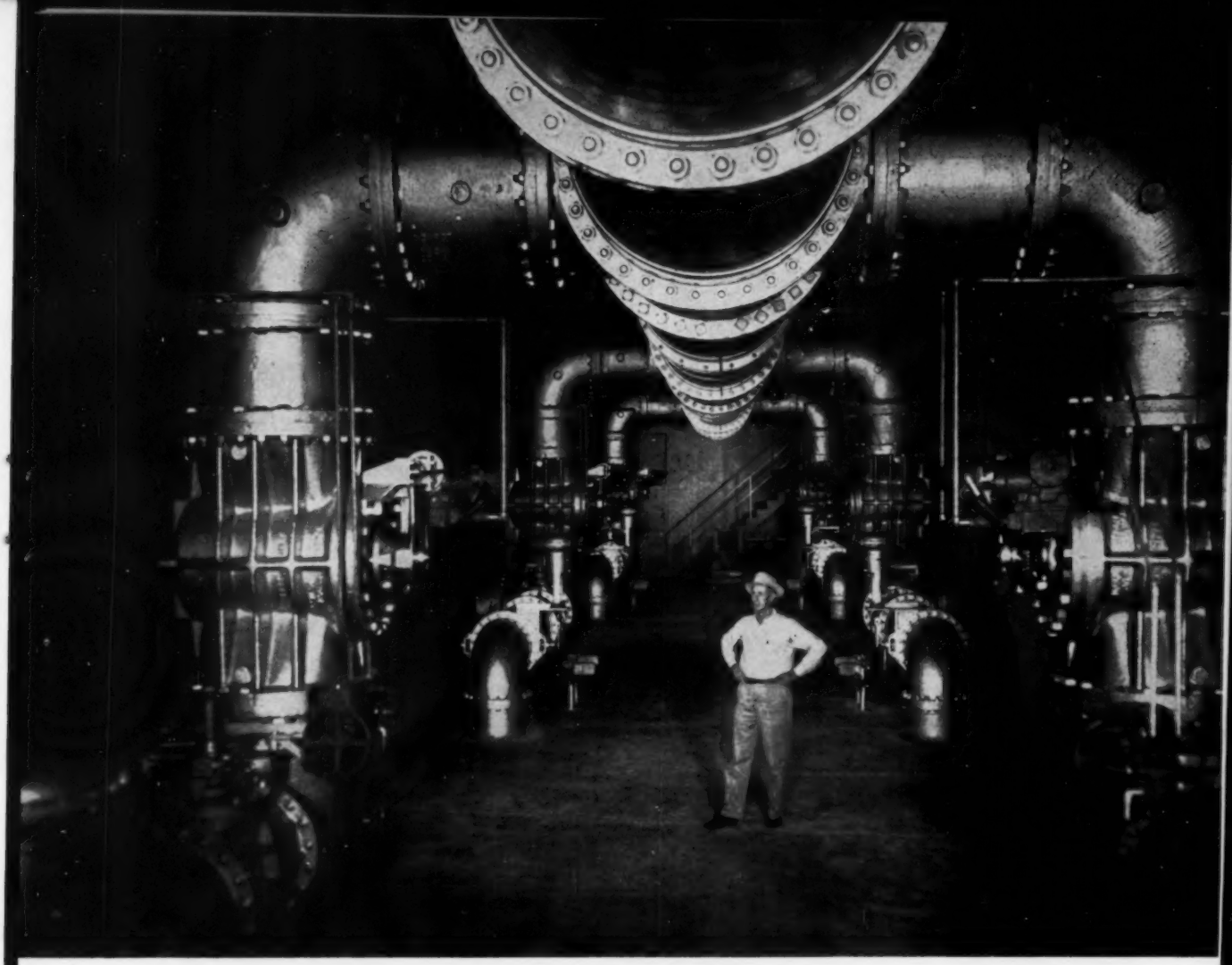

BIG SPACE SAVERS

The Rockwell-Nordstrom 24" pneumatically operated valves shown above are big, but they really *save space*. If they were ordinary valves, the bonnet cavity plus the operator would practically fill the aisle-way. Rockwell-Nordstrom lubricated plug valves always save space in water and sewage plants because they have no rising stems or bulky, heavy bonnets . . . usually they take little more space than the flange diameter.

But Rockwell-Nordstrom valves do more than just save costly space. They work easier because the *tapered plug* and lubricant hydraulic jacking action prevent galling and make the *quarter-turn operation* smooth and easy. And they *always cost less to use* because lubricant prevents metal-to-metal friction for longer valve life at lower cost.

Rockwell-Nordstrom valves come in a complete range of sizes and pressure ratings for every water or sewage plant need. They cost no more to buy—often less—than ordinary valves. Send the coupon for complete details. Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania. *Canadian Valve Licensee:* Peacock Brothers Limited.

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Rockwell Manufacturing Co.
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Time to plan for *your* city's future water needs

All around the U. S. A. communities are planning and making water main extensions in anticipation of their vastly increased future needs.

They are recognizing that population growth . . . increasing industrial water requirements . . . development of suburban and outlying areas . . . air conditioning . . . and greater use of water for many domestic purposes are stepping up demand by leaps and bounds.

An overwhelming majority of American communities are making water system extensions and improvements with

Permanent CAST IRON PIPE

"America's No. 1 Tax Saver"

because of its century and more of useful life, its minimum maintenance cost and superior shock-resistance and beam strength.

In your community, you too will find that Cast Iron Pipe will pay rewarding dividends for many long years to come.

WOODWARD IRON COMPANY

Since 1882

WOODWARD, ALABAMA

Our Company does not manufacture Cast Iron Pipe but supplies many of the nation's leading foundries with quality pig iron from which quality pipe is made.

CONNECT BRANCH MAINS under pressure . . . FAST!

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Mechanical Joint Tapping Sleeves and Valves

One Sleeve—One Gasket Fits All Classes of Cast Iron Pipe

No matter whether the pipe in your system is sand cast or centrifugally cast, the Iowa mechanical joint tapping sleeve . . . with one gasket . . . will fit your pipe. The end gasket is reinforced with a strong helical spring molded into the gasket rubber. Always a tight, permanent seal on all classes of cast iron pipe. And, with Iowa Mechanical Joint Tapping Sleeves and Valves, installation is easier, simpler, more economical. You save time, bother, confusion.

Write today for complete information.

Sleeves and Valves, 3 inches through 12 inches.

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Oskaloosa, Iowa *A Subsidiary of James B. Clow & Sons, Inc.*

"DON'T DRINK THAT!"

It's poison!

Polluted water not only endangers your life . . . it costs you money as well. Local pollution compels many communities to travel too far for drinkable water . . . and taxes climb.

If industry, our second greatest user, must purify water *before* using it, production costs soar. You pay more for goods.

Pollution robs you of your fun too . . . ruins fishing, swimming, boating.

Water officials ask your help in preventing pollution and solving other problems.

1. Encourage future water planning.
2. Support realistic water rates and water supply bond issues.
3. Conserve water where you can.

Water today is everyone's business!

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CAST IRON PIPE SAVES YOU TAX DOLLARS

This cast iron water main laid in Richmond in 1833 is still in excellent condition. Such performance is typical of many century old cast iron water and gas mains still serving throughout America.

Small wonder that where long life, dependability and economy are "musts," water officials prefer cast iron pipe . . . No. 1 Tax Saver!

CAST IRON PIPE
RESEARCH ASSOCIATION — SUITE 3440, PRUDENTIAL PLAZA, CHICAGO 1, ILL.

MODERNIZED **cast iron**

POLLUTION IS ONLY ONE OF YOUR PROBLEMS

Your biggest problem today, probably, is to make the public aware there *is* a water problem.

Advertisements like the one at the left . . . one of our continuing campaign on conservation* . . . do exactly that.

Not only do they dramatize our current water crisis; they stress the need for public cooperation and support for all water programs.

That continuing education makes your job easier.

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**Appearing in:* Saturday Evening Post, Newsweek, U. S. News and World Report, Nation's Business.

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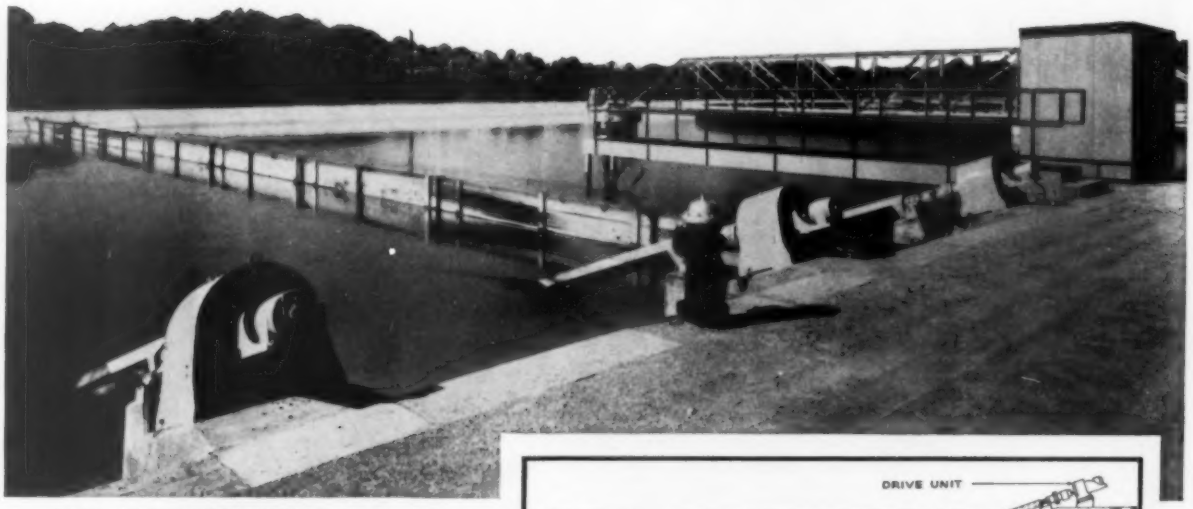
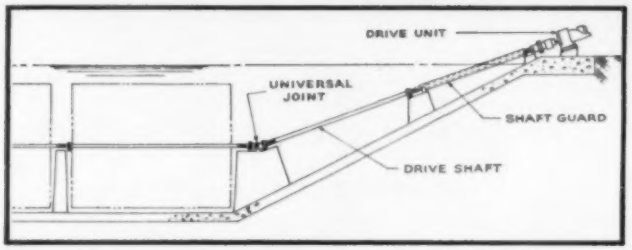
unique FLOCTROL® drive
...new **JEFFREY** design cuts costs 3 ways



Three Jeffrey FLOCTROLS at St. Louis County Water Treatment Plant, St. Louis, Missouri, employ unique parallel-to-inclined-sidewall drive arrangement.



Jeffrey sanitary engineers designed the unique FLOCTROL drive shown above. Shaft runs parallel to the inclined sidewall of clarification basin and underwater universal joint is coupled to the horizontal FLOCTROL shaft. Drive shaft is protected at water surface by a steel guard which prevents fouling due to ice formation.

This efficient new Jeffrey FLOCTROL drive affords 3-way savings:

It is less expensive than drives of conventional design • Eliminates costly concrete and steel superstructures • Eliminates undesirable sprocket and chain drive through water.

Jeffrey FLOCTROLS are available in horizontal and vertical types. Horizontal units are usually installed in large plants, vertical units in smaller plants. FLOCTROL Systems eliminate short circuiting through the basin . . . provide tapered mixing for fast floc formation . . . permit 30% smaller basins than are customarily required.

For details on all Jeffrey equipment for water, sewage and industrial waste treatment, write for Catalog 905. The Jeffrey Manufacturing Company, 996 North Fourth St., Columbus 16, Ohio.

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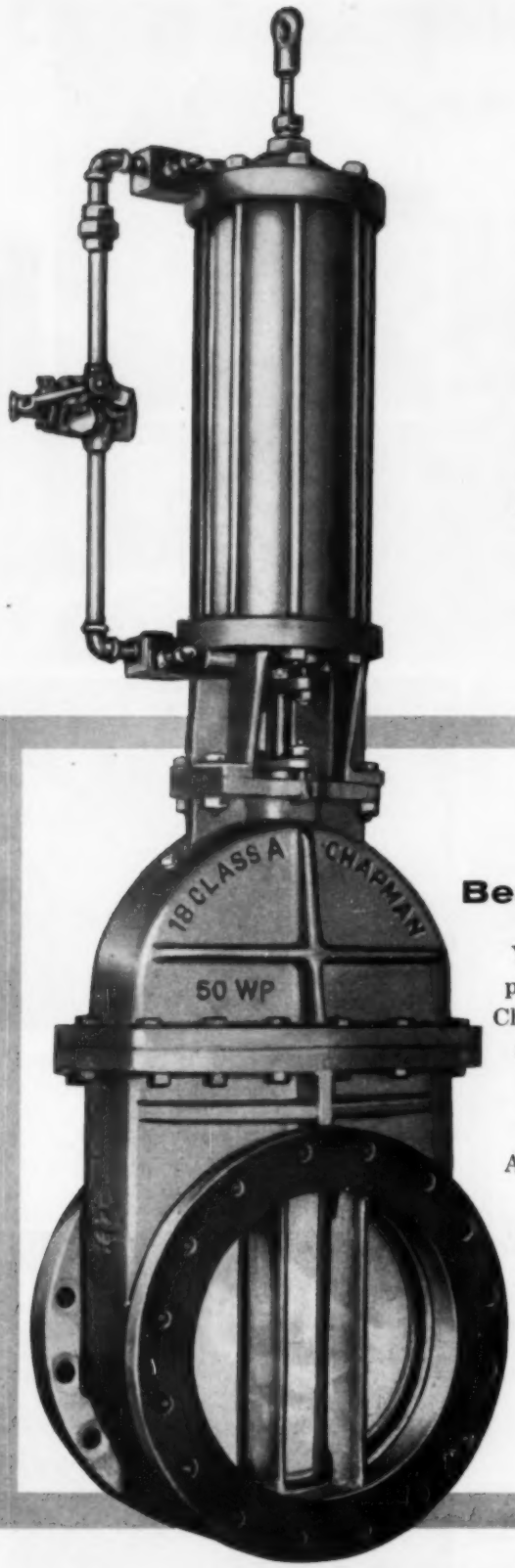

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Beamed Waterway Gate Valve

You get more bearing contact area. In the partly opened position, 6 to 10 times more bearing contact area with a Chapman than with any other double disc parallel seat or square bottom gate valve. You get long wearing bearing surfaces on the beams and downstream discs. You get smooth operation, tight seats and practically no leakage.

All this is yours for less . . . less trouble, less maintenance, less time out for repairs . . . even for decades of rugged service.

For filtration plants, wash water valve service or other places for limited throttling requirements, always specify Chapman Beamed Waterway Gate Valves. You get more for less. All standard sizes . . . any desired method of operation . . . are available. Write for our Catalog No. 45 today.

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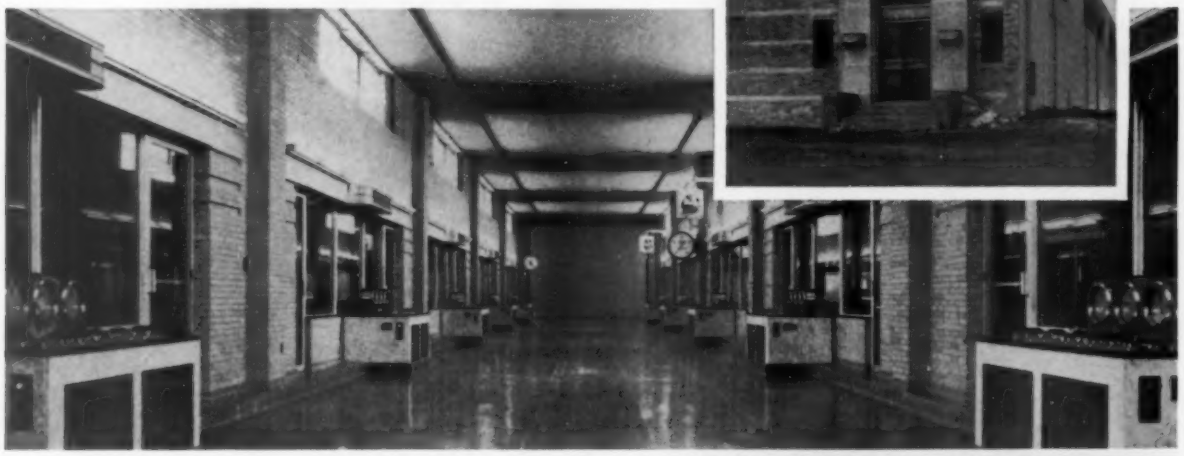
INDIAN ORCHARD, MASSACHUSETTS

For new 40 mgd addition to Toledo's Collins Park Filtration Plant...

CONS. ENG.—Finkbeiner, Pettis & Strout; COMM. WATER—Sol J. Wittenberg
CHIEF ENG. DIV.—George Van Dorp



34 years' accurate control makes it 100% Simplex again!

34 years of accuracy. No troubles. That's the service record of Simplex filter controllers, venturi tubes and meters at Toledo.

Dependable accuracy like this is essential to your plant, too. So take a closer look at Toledo's experience with Simplex:

1921 – 34 Simplex Controllers installed.

1929 – 22 Simplex Controllers added. (All 56 coordinated with Simplex Master Control System, including Gauges & Meters.)

1941 – New Collins Park Plant selects: 40 Simplex Rate Controllers. (Also Simplex W. W. controllers; 60" Venturi Tubes & Meters; plus Gauges & Meters.)

And again in 1956 for Toledo's expansion to 120 mgd – it's 100% Simplex with integrated Pneumatic Master Control. Equipment chosen: 20 Rate Controllers; 60" Venturi Tubes and Meters; Gauges; Wash Water Controllers.

Efficient performance – with minimum maintenance – saves money throughout the years. That's why it's wisest for budget-conscious communities to start with the best.

Write for Technical Bulletins – Simplex Valve & Meter Co., Dept.WS-10, 7 E. Orange St., Lancaster, Pa.

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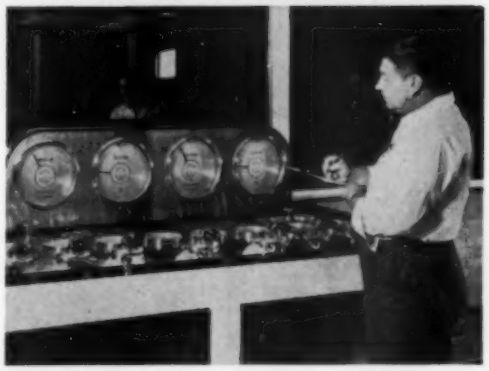


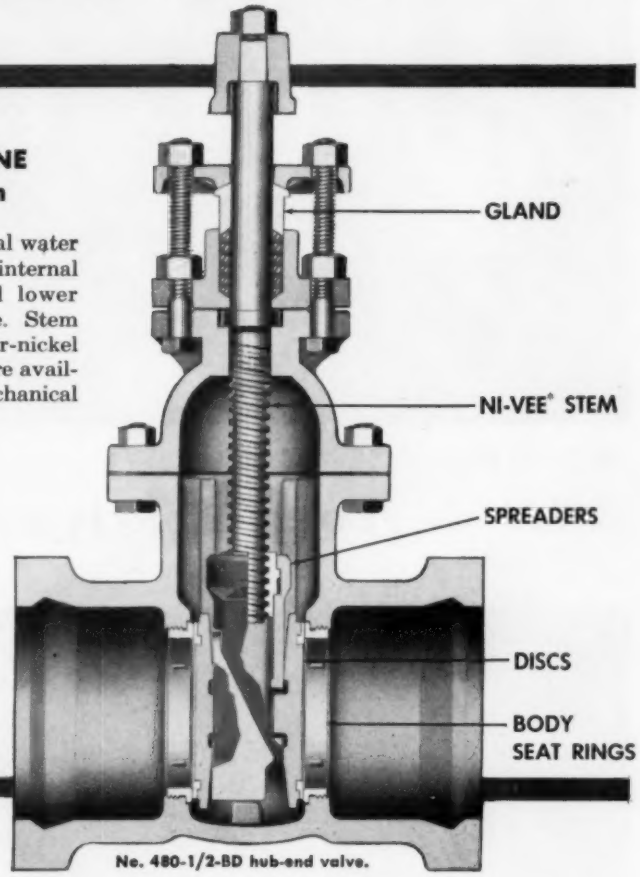
Compact group of easy-to-read Simplex gauges indicates rate and head loss for a pair of the 20 new 4-mgd each filter units

Part of the Simplex Pneumatic Master Control System that permits varying the rate of ten new filters from one location. This panel indicates, summates and records flow of raw, wash and filtered water

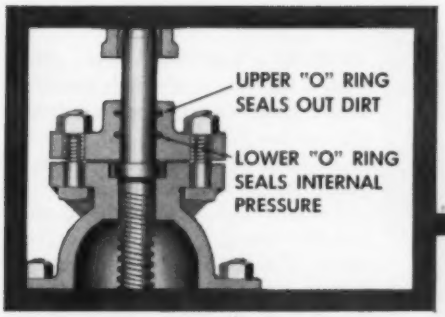
CRANE expands A.W.W.A. line for special needs

Water corrosive? Use CRANE valves with *all-bronze* trim

This Crane valve is for use where unusual water conditions require the use of all-bronze internal parts. Body rings, discs, upper and lower spreaders, and gland are of solid bronze. Stem is "Ni-Vee"* Type A bronze, a copper-nickel alloy of low zinc content. These valves are available from stock in hub, flanged and mechanical joint ends—in all sizes from 2″ to 12″.



No. 480-1/2-BD hub-end valve.



Double "O" ring stuffing box now available

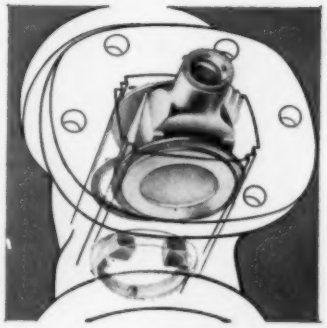
Another feature now available in Crane A.W.W.A. non-rising stem valves is an "O" ring stuffing box. Two Buna-N "O" ring seals hug the stem tightly. Lower ring acts to seal the internal pressure; upper ring is an external dirt seal and reserve pressure seal. Valves with "O" ring stuffing boxes are available with hub, flanged, mechanical joint ends—in all sizes from 2″ to 12″.

*"Ni-Vee" is the registered trade-mark of International Nickel Co.

Features of CRANE A.W.W.A. Valves justify their choice

Simple, 4-part double-disc assembly—2 discs, 2 spreaders. Discs are free to rotate—minimizing concentrated seat wear. Discs cannot fall out or jam. Easy opening and tight closing assured. Valves have much longer service life.

For complete details on these valves, write for circular AD-2108.



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Long Beach gets deep drainage

Fairbanks-Morse mixed-flow pumps, driven by F-M motors shown above.

To drain a residential area, along with a freeway underpass reaching under Long Beach Boulevard, the city of Long Beach, Calif., has installed one of the deepest drainage pump stations on record.

For low-cost, dependable pumping the Long Beach authorities chose Fairbanks-Morse motor-driven pumps, rated 25,500 gpm. at 28.5′ total head. Expertly engineered, the installation provides reserve capacity to meet the most severe storm.

Whether your pumping problem is municipal or industrial—involves water disposal or water supply—you'll move more gallons at less cost by selecting the right type, right size pump from the broad F-M line. Why not call your Fairbanks-Morse Field Engineer now? He'll be glad to work with your own engineers in planning low-cost, efficient modernization of your facilities. For information, write Fairbanks, Morse & Co., Dept. WSW-10, 600 So. Michigan Ave., Chicago 5, Ill.

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"A-2" Machine inserts or removes corporation stops 1" to 2" pipe plugs 1" to 4"

"B" Machine inserts or removes corporation stops ½" to 1" pipe plugs ¼" to 2¼"

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tapping machines

give accurate alignment

for simple, trouble-free operation!

Use a tapping machine with only *one* boring bar and guarantee accurate alignment, assure uniformly tapped hole and eliminate possibility of cross-threading your corporation stops.

Mueller "A-2" and "B" Tapping Machines drill and tap the main in a single operation. The combined drill and tap tool is then replaced—on the same boring bar—with the corporation stop to be inserted. Alignment is automatic and stop is inserted quickly and efficiently!

Difficulties, such as a defective thread or a tool or stop of the wrong size, are easily overcome with Mueller Tapping Machines. A flop valve between the two pressure chambers permits the boring bar and upper portion of the machine to be removed at any time during the drilling and tapping or inserting operations.

Contact your Mueller Representative, refer to your Mueller Catalog W-96 or write direct today.

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for dependable pipe line equipment

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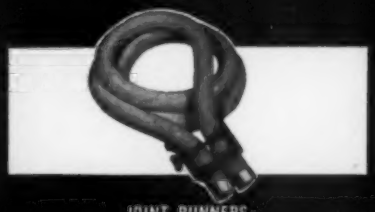
Here, under one roof and listed in one comprehensive catalog, are all the time and money saving products you need on the job. Each is guaranteed for dependability, economy. Each is backed by Pollard service.



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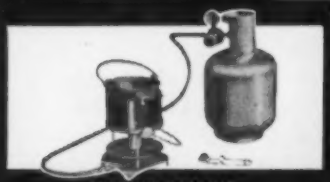

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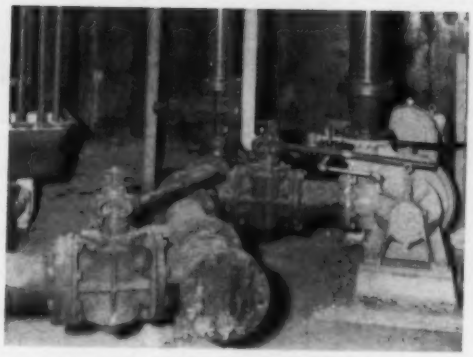
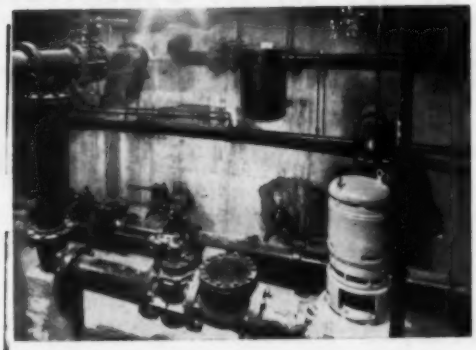
Why DeZURIK VALVES?

More and more consulting engineers are specifying DeZurik Easy-Operating, Non-Lubricated Valves. Why? Some of the reasons are given below.

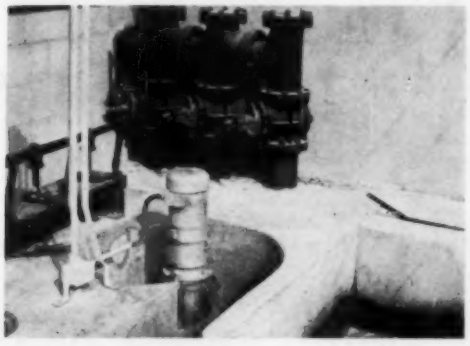


These DeZurik Valves, installed in the Connersville (Indiana) Sewage Treatment Plant, are on digested sludge lines from the digester tanks. The resilient-faced plug of DeZurik Valves seal tight despite solids in the flow.

At the Municipal Sewage Plant in St. Cloud, Minnesota, DeZurik Valves are installed on suction lines from the clariflocculators and throughout this modern plant. They open or close easily—without jamming, without continual, costly maintenance.



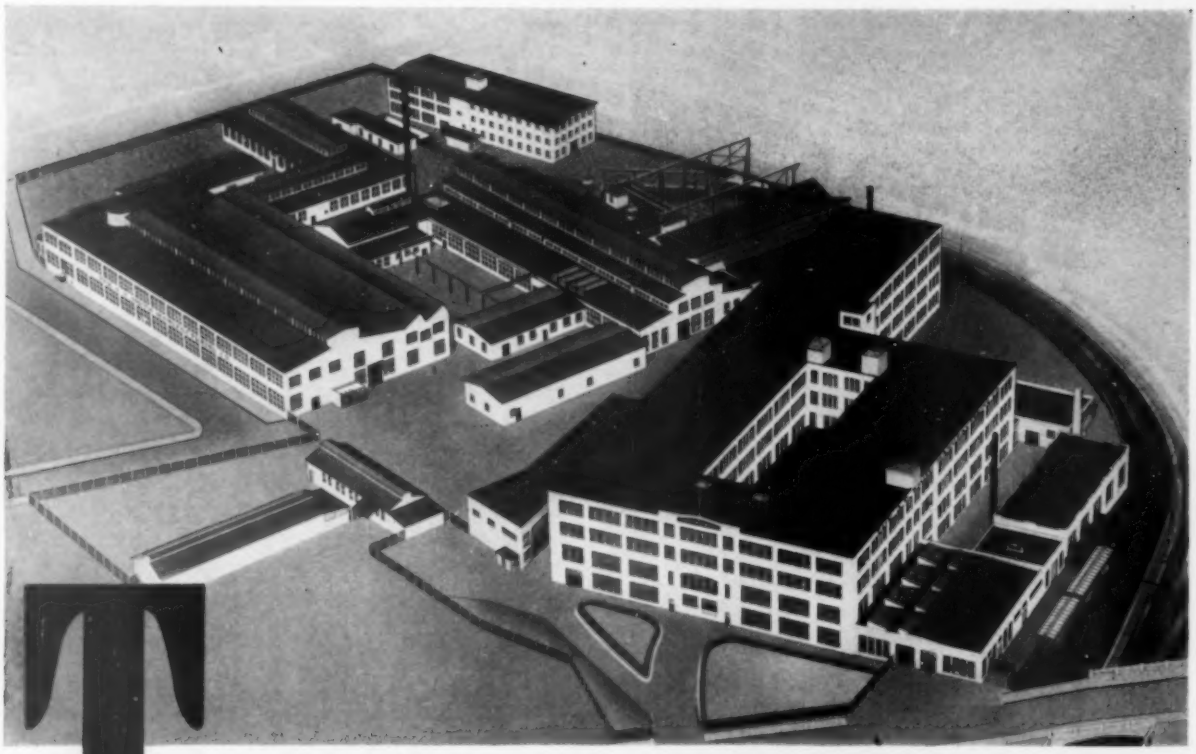
The Flat Rock Sewage Treatment Plant at Tulsa, Oklahoma, has installed DeZurik Plug Valves on a number of services. And they operate with top efficiency on *all* lines from heavy sludge to gas.



Note the short operating levers on these DeZurik Valves installed on sludge lines to the digester from the primary settling tanks in the Sewerage Plant in Bellevue, Washington. DeZurik Valves open wide or close tight with an easy quarter-turn . . . without lubrication!

These are just a few of the reasons why more DeZurik Valves are going into operation in sewage treatment plants throughout the country. Get the complete story; write for more details to

DeZURIK CORPORATION
SARTELL, MINNESOTA



THE A. P. SMITH MANUFACTURING CO.

produces, FIRE HYDRANTS A. W. W. A. Specification and High Pressure — Compression Type — Dry and Wet Barrel Types. GATE VALVES sizes 2" thru 66", Manual, Hydraulic Cylinder, Electric Motor Operated for Low, Medium and High Pressure Service. INSERTING VALVES sizes 4" thru 48" for inserting under pressure. TAPPING SLEEVE AND VALVES sizes 4" x 2" thru 60" x 48" for branch connections under pressure.

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. . . for treating domestic and industrial wastes

18-month test shows HI-CONE system operating costs are 44% less!

than air diffusion system

- TESTS PROVE LOWER POWER COSTS!
- LOWER MAINTENANCE COSTS!
- BETTER EFFLUENT

In the selection of sewage treatment equipment, the two most important factors are operating cost and effluent quality.

These figures from the annual report of the Manchester, England, Rivers Department, *prove* the superiority of the Hi-Cone! They're based on the operation of activated sludge plants (including a Hi-Cone System and a diffused air system) under strictly comparable conditions over a period of 18 months. Manchester is a pioneer in treatment by the activated sludge process, having first conducted experiments and tests in 1913.

Hi-Cone's power consumption was lower! Horsepower demand per million gallons treated per 24-hour day for the Hi-Cone System was 34.9% lower than the air diffusion system.

Hi-Cone's total operating costs were lower! Relative costs per million gallons treated were 42.1% lower than the air diffusion system.

Hi-Cone's effluent was better! The B.O.D. reduction was 26% greater; the suspended solids removal was 5% greater than the air diffusion system.

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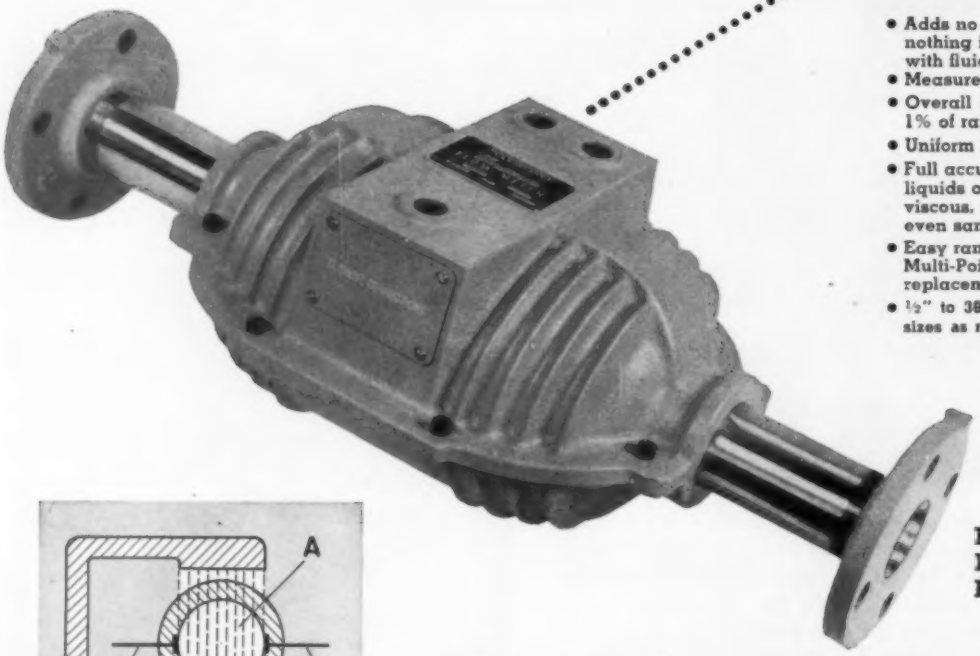

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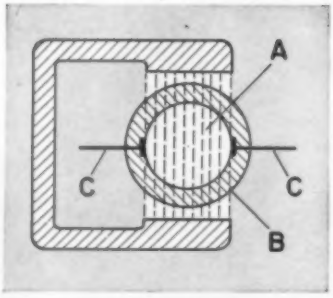

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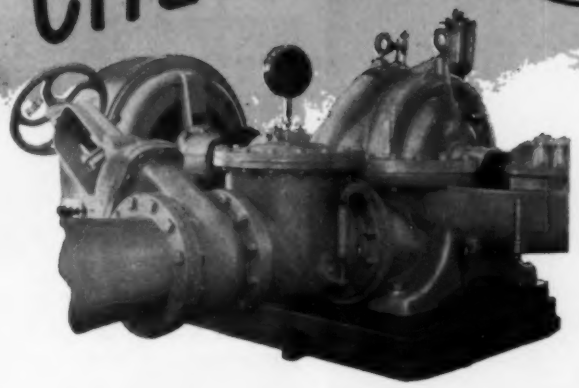
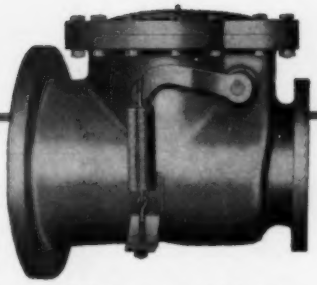
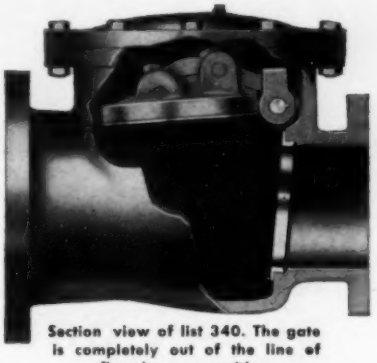




List 340 Clearway, quiet closing check valve: increasing type with flange ends.



Section view of list 340. The gate is completely out of the line of flow in open position.

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22

Ask for Bulletin "E"

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View from downstream side shows final connection of one of the several hydraulic operating cylinders for each gate. Piping on the face of the dam immediately below provides individual isolation of any cylinder.

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New SMS Bascule Gate Design Provides a CLEAR CREST, UNLIMITED LENGTH

Now SMS Bascule Gates can be built to any length you need, and installed without intermediate piers or overhead structures. With this new SMS design, hydraulic operators are located under the gate leaves and controlled from either end. The installation shown above consists of two 233'9" gates. They are the longest ever installed.

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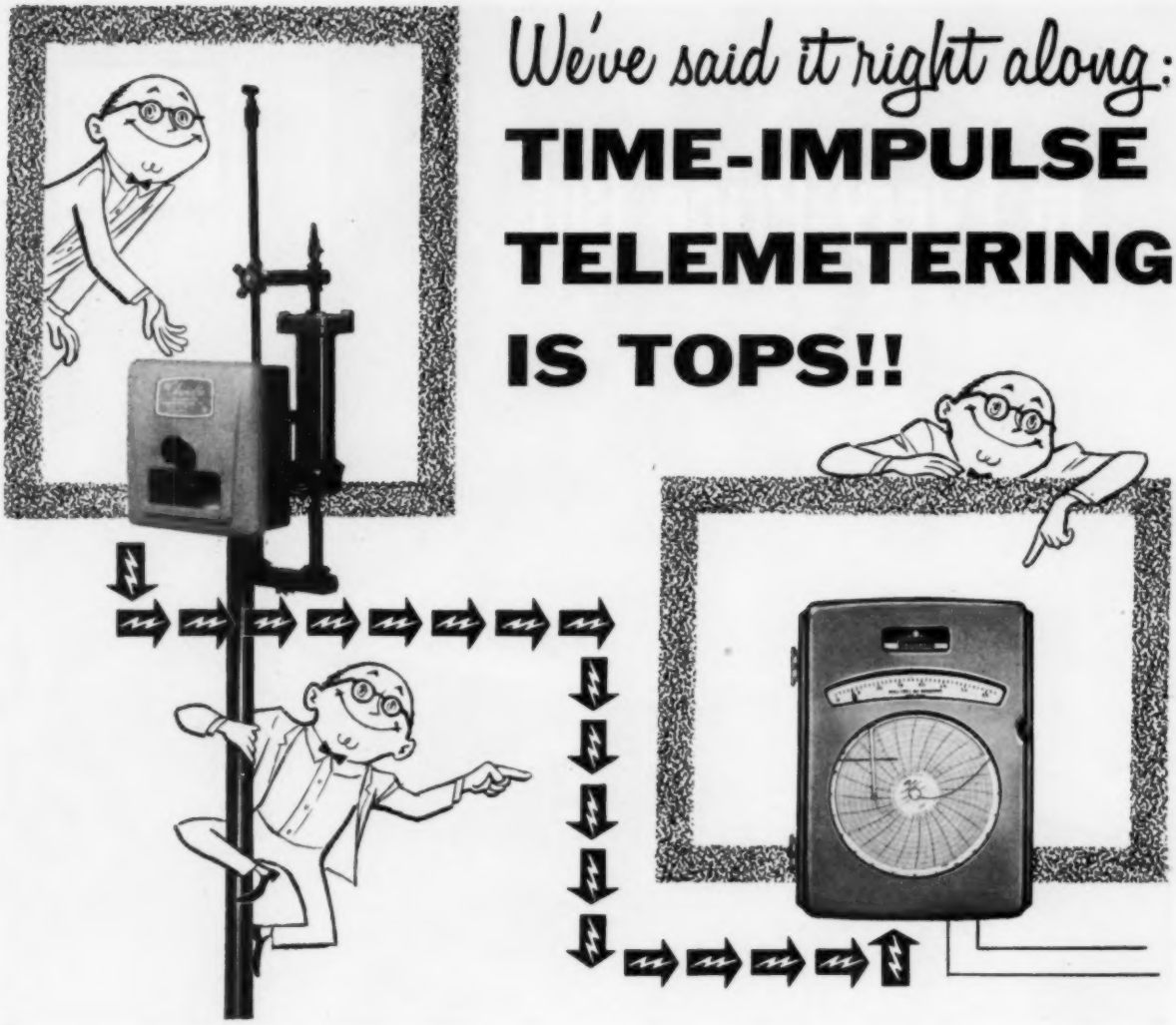

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WATER & SEWAGE WORKS

VOL. 104, NO. 10 • A Scranton Gillette Publication • OCTOBER, 1957

MAIN Booster Pumping Station, Foothill Municipal Water District, Pasadena, Calif.

Submersible Pump Applications in Booster Pumping

Provide quiet operation, low construction costs, and friends for the water utility.

by R. C. KENMIR

Mr. Kenmir is chief engineer in the office of James M. Montgomery, Consulting Engineer, Pasadena, California.

While on the Pacific Coast we became impressed with the adaptation of submersible pumps to sizable booster stations in residential areas, and have been fortunate in obtaining this story relating the why and how of quiet booster pumping with submersibles.

BOOSTER PUMPING stations in residential areas have always posed a design and construction problem to the water works engineer.

If a building is put up to house the pumps, it must be attractively designed and properly maintained to avoid public criticism; and, if operation of the equipment can be heard at night by the neighbors, the water superintendent can expect endless complaints. The problem can be especially difficult if the pumping units are fairly large or of a size to cause frequent start and stop operation.

The submersible motor pump unit offers a satisfactory way of eliminating much of the noise in booster pumping stations, although consideration must still be given to the noise produced by the transformers, starting equipment and pump control valves. Unless the station is quite large, transformer hum usually is not serious. Starting equipment for large units and especially for equipment operating on voltages in excess of 480 volts, is sometimes quite noisy. Some types

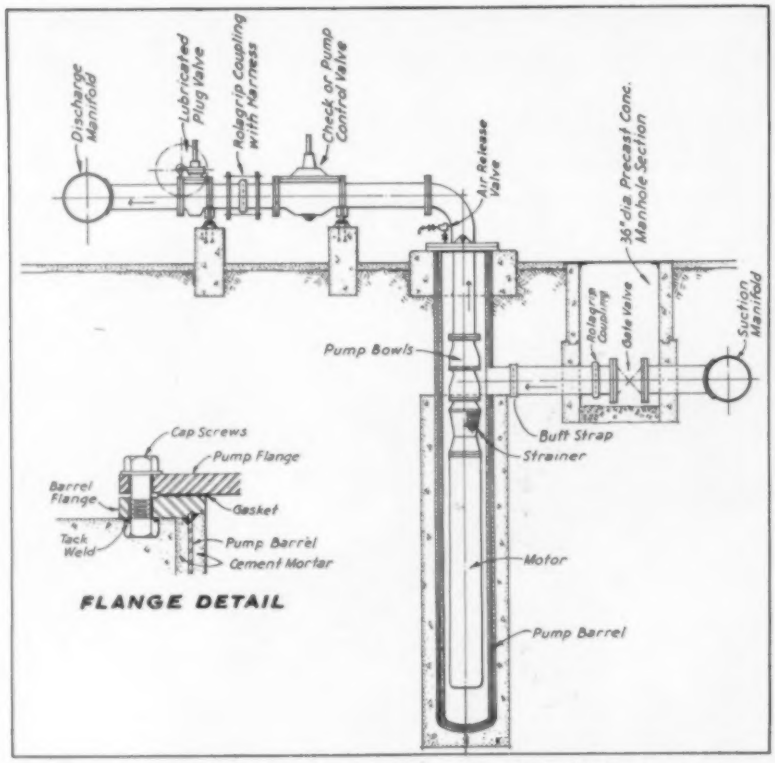


Fig. 1—DRAWING of a typical installation of a submersible booster pump.

of pump control valves using solenoids produce objectionable hum. Where the noise must be kept to an absolute minimum it is sometimes necessary to house all sound-producing components; and, if necessary, provide suitable insulation to deaden the sound.

Fig. 1 illustrates the usual method of installing submersible pumps as boosters. The pump and motor unit is set in a vertical section of pipe (usually referred to as the "barrel") with the pump and motor suspended from a flange which, in turn, is bolted to the flange on the barrel. The flanged joint is provided with a gasket and designed for the maximum pressure to which the barrel may be subjected. If desired, the pump discharge and discharge valves may be installed in a vault below ground.

Although the use of submersible motors ordinarily limits the type of pump to a vertical pump, some industrial installations have been made in which submersible motors have been used to drive horizontal pumps. During recent years there has been a decided trend in booster pumping toward the use of vertical turbines, driven by either submersible or conventional motors. However, this trend has been more pronounced in the western part of the United States than elsewhere. In considering the proper pump for any given application in booster pumping the advantages and disadvantages of the various types of pumps which might be used should be given careful consideration. Some of the advantages and disadvantages of vertical turbine pumps are outlined below.

ADVANTAGES OF TURBINE PUMPS:

(1) Vertical turbine pumps require no housing in mild climates although in very cold climates, housing or other protection may be needed to prevent freezing of the discharge piping. Conventional motors may require housing in order to muffle the sound of the motors.
(2) By setting the pump barrels for vertical turbines at the proper depth or by setting the pumps directly in a reservoir or sump, below-ground pump rooms or vaults can be avoided. Thus, with the motors set above ground, the danger of flooding from a break in the piping or from outside sources is eliminated.
(3) In some systems, the total head may fluctuate over a very wide range. Such a condition may be met easily with the vertical turbine without providing an excessively large motor. This is due to the relatively steep curve characteristic of the vertical turbine pump.
(4) The vertical turbine permits great flexibility in meeting changed head conditions. If at the time the pump is purchased, it is anticipated that head conditions may be increased in the future, the motor and shafting can be sized accordingly and later, additional bowl units added to meet the higher head condition. In the event a lower head condition is to be met, the bowl assembly may be simply destaged.
(5) A minimum amount of maintenance is required.
(6) A minimum amount of floor space is required.

DISADVANTAGES OF TURBINE PUMPS:

(1) The initial cost is greater than for either a vertical volute-type pump or a horizontal double suction pump.
(2) If housed, vertical turbines require considerable head room.
(3) Repairs to the pump are rather expensive, since the pump must be removed from the well or pit and usually must be sent to a repair shop.

In addition to the above advantages and disadvantages common to both conventional and submersible motor-driven turbine pumps, the submersible motor-driven unit has the following advantages and disadvantages.

ADVANTAGES OF SUBMERSIBLE PUMPS:

(1) Freedom from noise of any consequence.
(2) Protection against any kind of weather.
(3) Protection against tampering.
(4) Increased safety to both persons and mechanical equipment.
(5) Practically maintenance-free performance without need of adjustment or lubrication.

DISADVANTAGES OF SUBMERSIBLE PUMPS:

(1) Although efficiencies of the conventional vertical motor are usually comparable to those of the horizontal motor, the efficiency of the submersible motor is generally slightly lower than either type of conventional motor, due to the drag of the coolant within the motor. This difference, however, is of very little significance in the case of motors of under 100 hp.
(2) The submersible motor is more expensive than either the conventional vertical motor or the horizontal motor.
(3) Where submersibles are used for boosting, it is generally necessary to provide a relatively deep pump well or "barrel," due to the fact that the motor is attached to the pump below the bowl assembly and suction strainer of the pump.
(4) In the case of some submersibles, if any trouble develops within the motor it cannot be repaired in the ordinary motor shop but must be sent to the factory. However, some makes are of such design as to permit rewinding in local motor repair shops.

The following figures give some idea of the growing popularity of the submersible pump. One of the leading manufacturers of submersible pumps estimates that in 1956 between 60,000 and 70,000 submersibles were sold in the United States. This figure is broken down into the various sizes as follows:

⅓ to 5 hp	60,000
5 to 20 hp	2,000
20 to 75 hp	500
75 to 200 hp	250
200 to 500 hp	100

History of the Submersible Motor

Development of the submersible pump stems from the need to eliminate the inefficiency of conventional turbine pumps when installed in very deep wells. Pumps with settings several hundred feet below the ground have so many line shaft bearings there is a substantial loss in efficiency. The shaft (and tube in the case of oil lubricated units) represents an obstruction to flow which further reduces the efficiency of the conventional deep-well turbine. Some of the early designs were intended for use in oil wells and others were intended for use aboard ships.

The first patent on a submersible motor was issued in England to W. R. MacDonald in 1908 on a "wet-stator" type in which no attempt was made to exclude water from the windings. This design required heavy insulation on the individual conductors.

During the next two decades, there were many unsuccessful attempts made by both English and American manufacturers to develop a reliable submersible motor. Although some of the designs were very ingenious, most of them failed to prove the reliability required for practical applications.

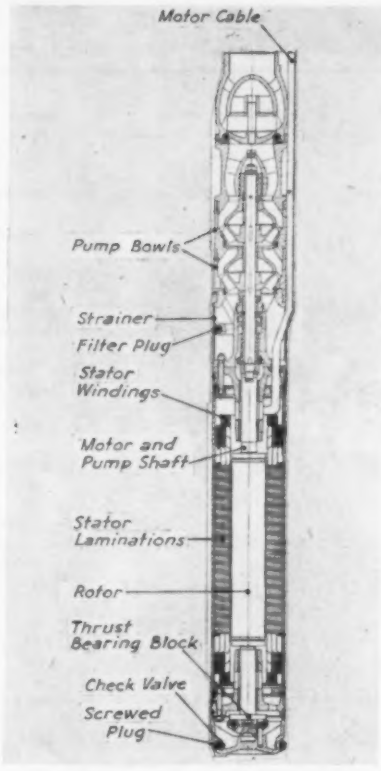


Fig. 3—SECTION of Pleuger Co's. submersible motor. (German-designed wet stator water-filled motor—1/3 to 550 hp.)

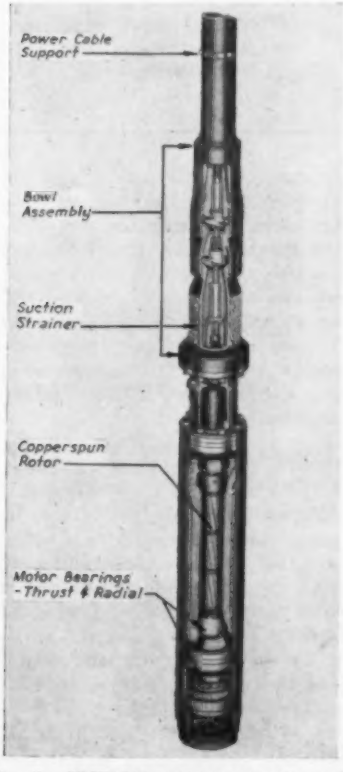


Fig. 2—SECTION of Fairbanks, Morse & Co's. submersible motor. (Wet stator water-filled motor with mechanical seal —15 to 200 hp.)

One of these was an "air-bell" type of English manufacture in which the housing was kept filled with air with the bottom of the housing open to the water. In 1921, a patent was issued to William Baum of Milwaukee, Wis, on a rather conventional appearing motor designed for underwater service. The water was prevented from entering the motor by keeping the motor housing under the proper pressure with air supplied from an external source.

A rather ingenious English design consisted of a completely enclosed and sealed motor which drove the pump through two magnetic couplings separated by a thin diaphragm. One of the magnetic couplings was on the motor shaft sealed within the motor housing and the other was on the pump shaft in water. Water works men will recognize this drive as being similar to that now used on a popular propeller-type water meter in which the magnetic drive is located between the propeller and the sealed gearing. Another English design consisted of a conventional motor equipped with intricate mechanical seals.

It was not until the late 1920's that submersible motors were used to any great extent. The submersibles built during this period were of two types known as the "dry-stator" and the "oil-filled" types. The former was developed by Garvenswerke of Austria and the later by Reda Pump Company of Oklahoma and Submersible Pump Company of Los Angeles. The latter firm was taken over in 1936 by Byron Jackson Company. Several English and European manufacturers were marketing submersible motors of the "dry-stator" and "wet-stator" types prior to World War II.

Types of Submersibles

The general characteristics of the various types of submersibles in current use are discussed in the following paragraphs.

Wet-Stator Types

In the wet-stator type, water is free to circulate throughout the motor. This requires all individual conductors to be insulated with either rubber or plastic. Although rubber was formerly used, the insulation now generally used is polyvinylchloride or polyethylene plastics. All parts in contact with the water, except the rotor and stator laminations, are usually made of non-corrosive materials. Due to the fact that non-corrosive materials do not have the magnetic prop-

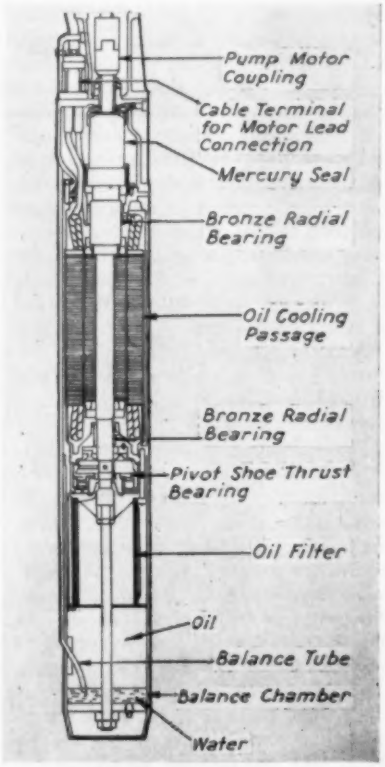


Fig. 4—SECTION of Byron-Jackson Co's. submersible motor. (Oil-filled motor with mercury seal—5 to 750 hp.)

TABLE 1

Manufacturers of Submersible Motors and Types Offered

Manufacturer	Location	Motor Horsepower	Type	Coolant	First Offering
AMERICAN MAKES					
Byron Jackson Pumps, Inc.	Los Angeles, Cal.	5—750	Open Winding	Oil	1928
Reda Pump Co.	Bartlesville, Okla.	⅓—300	Open Winding	Oil	1920*
Fairbanks, Morse & Co.	Beloit, Wis.	15—200	Wet Stator	Water	1950
General Electric Co.	Fort Wayne, Ind.	⅓—5	Plastic Impreg. Wind.	Water & Glycol	1953
General Electric Co.	San Jose, Cal.	Up to 125	Open Winding	Oil	
U. S. Electrical Motors, Inc.	Los Angeles, Cal.	⅓—3	Plastic Impreg. Wind.	Water-oil Emul.	1953
U. S. Electrical Motors, Inc.	Los Angeles, Cal.	Up to 75	Dry Stator	Water & Glycol	
Pleuger Pump, Inc.	Lancaster, Pa.*	⅓—550	Wet Stator	Water	1929
Jacuzzi Bros., Inc.	Richmond, Cal.	1—25	Open Winding	Oil	1945*
Franklin Electric Co., Inc.	Bluffton, Ind.	⅓—20	Dry Stator	Water	1950
Jack and Heintz, Inc.	Cleveland, Ohio	⅓—3	Plastic Impreg. Wind. and Open Winding	Oil	1952
Sumo	Stamford, Conn.	⅓—60	Dry Stator	Water grease	1938
ENGLISH MAKES					
Beresford	England	½—170	Dry Stator	Water-oil Emul.	1951
Hayward-Tyler	England	3—450	Wet Stator	Water	1920
Sumo	England	⅓—60	Dry Stator	Water-grease	1938
EUROPEAN MAKES					
Klein, Schanzlin & Becker	Germany	½—1000	Wet Stator	Water	1930
Aturia	Italy	¾—7	Dry Stator	Water-oil Emul.	1940
Garvens	Austria	½—3	Dry Stator	Water-grease	1923

*Also Germany

*approx. years

erties required, carbon steel must be used for the rotor and stator laminations. Some manufacturers use special methods of treating the laminations so as to reduce the corrosive effect of the water. Proponents of oil-filled motors maintain that corrosion of the steel laminations, and in some waters, formation of scale in a wet-stator motor make this type of construction undesirable. However, manufacturers of the wet-stator motor point to their records of successful experience. Most manufacturers of the wet-stator motor recommend filling the motor with *clean* water and sealing the water in the motor, although some permit the motor to simply "soak up" water from the well or sump in which the pump is installed. "Sealing" in the water, as used with reference to wet-stator motors, is a relative term. Even with a mechanical seal, it is likely that there will be some interchange of water between the well or sump and the interior of the motor housing unless means are provided to take up the thermal expansion and contraction of the internal fluid. It is believed that the apparent lack of serious corrosion of the laminations in wet-stator motors can be attributed to the fact that once the small amount of oxygen in the water has been used up through the formation of corrosion products, there is no way for the oxygen to be replenished except from the small amount of interchange water which may enter motors of some designs. Hence, further corrosion is negligible. Usually means are provided for circulating the water within the motor in order to insure uniform temperature throughout the motor and to aid the dissipation of heat.

The Fairbanks, Morse and Company wet-stator motor is illustrated in Fig 2. This motor is very similar to the English-made Hayward-Tyler motor and in fact it is manufactured under Hayward-Tyler patents. Until recently, Fairbanks, Morse imported the Hayward-Tyler motor for use with Fairbanks, Morse pumps.

The Pleuger Pumps, Inc. wet-stator motor is illustrated in Fig. 3. The latter motor is of German design but is now manufactured in Lancaster, Pa. as well as in Hamburg, Germany. Although the wet-stator motor has not been widely used in the United States, it has been sold by both English and European manufacturers all over the world. In service, it has proved very successful. Motors of this type up to 450 hp are built in England and up to 1000 hp in Germany.

Dry-Stator Types

In the early 1920's the dry-stator motor was developed in Europe by adopting the idea of the European refrigerator motor which was built with a very thin stainless steel tube in the bore of the motor which sealed the refrigerant off from the stator windings. In the case of the submersible motor, the rotor, bearings, etc. are submerged in a coolant of water, water-oil or water-grease emulsions. Where the coolant used is water, it may or may not be sealed in the motor, depending upon the individual design. One of the advantages of this

motor from a manufacturing standpoint is that standard varnished windings can be used. In the case of some designs, the dry-stator motor has been found to be very sensitive to temperature rise. A very substantial rise in temperature has been known to cause collapse of the stainless steel tube. Some manufacturers of this type motor have overcome this potential weakness by filling the stainless steel tube or "can" with certain very stable polyester resins and fillers having a high thermal conductivity. Dry-stator motors of this type have proved highly successful. The Franklin Electric Company's dry-stator motor of this type is illustrated in Fig. 6.

Oil-Filled Open-Winding Type

The largest submersible motors manufactured in the United States are of the oil-filled open-winding type. From a manufacturing standpoint, this type is very desirable because the oil lubricates all wearing surfaces and protects all parts from corrosion, thus permitting the use of less expensive carbon steel and cast iron parts. Another advantage is the fact that standard varnished windings may be used. Some makes using standard windings are so constructed that they may be wound in any well-equipped motor repair shop. Most designs provide means for circulating the oil which helps to maintain fairly uniform temperatures throughout the motor and aids in the dissipation of heat. Certainly a most important part of an oil-filled motor is the seal between the shaft and the motor housing at the top of the unit. The seal must be of such design as to limit the loss of oil to a very small amount. Otherwise,

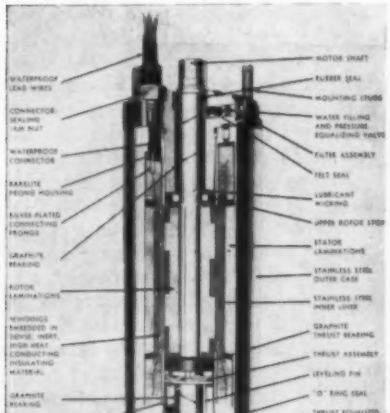


Fig. 6—SECTION of Franklin Electric Co's. submersible motor.
(Dry stator motor with rotor submerged in water and rubber and folt seal—1/3 to 20 hp.)

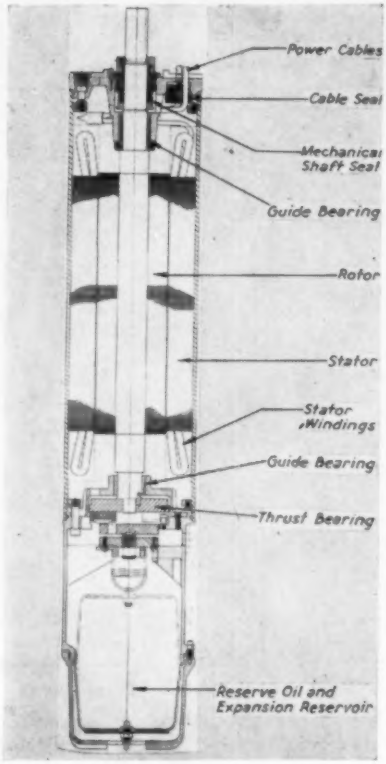


Fig. 5—SECTION of General Electric Co's. submersible motor. (Oil-filled motor with fechanical seal—5 to 125 hp.)

the oil in the water being pumped would become objectionable. Also, means would have to be provided to replenish the oil supply. Two types of seal are used—a mercury seal and a mechanical seal. The mercury seal is recognized as being very satisfactory, but in the smaller size motors it is considerably more expensive than a mechanical seal. One of the minor disadvantages of an oil-filled over a water-filled motor is the greater drag imposed on the rotor by the oil due to the viscosity of the oil. However, some manufacturers of this type of motor guarantee as high efficiencies as competing manufacturers guarantee for their wet-stator motors. Figure 4, showing the motor design of Byron Jackson Pumps, Inc. and Figure 5, showing the General Electric Company motor design, illustrates two different designs of the oil-filled type submersible.

Plastic Impregnated Stator Windings

One of the more recent submersible motor designs (Fig. 7) is that of U. S. Electrical Motors, Inc. of Los Angeles, which consists of a stator with plastic lined slots. After winding, the slots are completely filled under a special process with a plastic which fuses with the plastic liner, thus sealing the windings completely. This motor is filled at the factory with the coolant and the unit sealed. Motors up to 3 hp are filled with a water-oil emulsion; larger units are filled with water and glycol. General Electric Company uses a somewhat similar design for motors in sizes of 0.33 to 5 hp. The coolant used is a mixture of water and glycol. General Electric motors in sizes larger than 5 hp are open-winding type filled with oil. The design used by U. S. Electrical Motors for sizes larger than 3 hp is similar to the conventional dry-stator type except that all voids inside the stainless steel tube, or "can," are filled with a plastic in order to improve the cooling characteristics of the motor. Both the U.S. and G.E. motors are equipped with mechanical type of seals and neoprene diaphragms to provide for the thermal expansion and contraction of the coolant.

A motor with plastic impregnated stator windings is manufactured by Jack and Heintz, Inc.

Discussion of Various Types

Where the liquid coolant is sealed in the motor, means are generally provided to take care of the thermal expansion and contraction of the coolant. This is usually accomplished by installing a diaphragm at the bottom of the motor housing which is free to move upward or downward as the volume of coolant within the motor changes with temperature change. Some manufacturers spring-load the diaphragm in order to insure a somewhat greater pressure on the inside of the motor than on the outside for

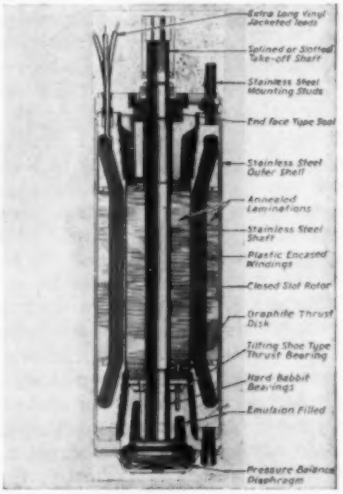


Fig. 7—SECTION of U. S. Electrical Motor Co's. submersible motor.
(Water—oil emulsion filled motor with mechanical seal—1/3 to 3 hp.)

TABLE 2

Actual Prices Paid for Submersible Pumps in Various Installations

Location	Owner	Year Purchased	No. of Units	Capac. gpm	Head ft.	Motor hp	Make of Motor	Cost per Unit	Cost per hp
Inglewood, Calif.	City of Inglewood	1953	2	750	75	20	B.J.†	$2,733.55	$137
Inglewood, Calif.	City of Inglewood	1953	2	750	90	30	B.J.	3,028.50	101
Inglewood, Calif.	City of Inglewood	1953	1	850	150	60	B.J.	3,666.00	61
Inglewood, Calif.	City of Inglewood	1953	1	3000	80	75	B.J.	4,295.68	57
Inglewood, Calif.	City of Inglewood	1953	2	1750	150	100	B.J.	4,585.00	46
Inglewood, Calif.	City of Inglewood	1953	2	1550	170	100	B.J.	4,585.00	46
Pasadena, Calif.	Foothill Mun. Water Dist.	1954	3	1550	350	175*	B.J.	5,897.00	34
Pasadena, Calif.	Foothill Mun. Water Dist.	1954	3	2450	305	250*	B.J.	7,297.00	29
LaCanada, Calif.	Foothill Mun. Water Dist.	1954	3	1400	485	200	B.J.	6,127.00	31
Henderson, Nev.	Basic Management, Inc.	1954	5	4200	300	400*	B.J.	10,600.00	27
Whitney, Nev.	Las Vegas Valley Water Dist.	1954	4	2400	462	350*	B.J.	10,350.00	30
Crescenta, Calif.	Crescenta Co. Water Dist.	1955	1	500	600	100	B.J.	5,875.00	59
Crescenta, Calif.	Crescenta Co. Water Dist.	1955	1	1000	600	200	B.J.	7,144.00	36
Beverly Hills, Calif.	City of Beverly Hills	1955	2	2400	112	100	B.J.	5,400.00	54
Beverly Hills, Calif.	City of Beverly Hills	1956	2	1500	265	125	B.J.	5,371.00	43
Monrovia, Calif.	City of Monrovia	1957	2	300	400	50	G.E.‡	3,220.00	64
Monrovia, Calif.	City of Monrovia	1957	2	600	210	50	G.E.‡	2,935.00	59
Monrovia, Calif.	City of Monrovia	1957	2	1500	234	125	G.E.‡	3,973.00	32

*2300-volt motors. All others 440-volt motors. All motors are 4 pole.
†Byron Jackson Pumps, Inc., Los Angeles, Calif.
‡General Electric submersible motors with Layne Bowler turbine pumps.
With the exception of the Beverly Hills installations, all pumps were purchased by the owner directly from the manufacturer.

the purpose of reducing the possibility of water in the well or sump from being sucked into the motor. In addition to the diaphragm, used to take care of the expansion of the water coolant, some wet-stator designs which provide for sealing in the water coolant, include a ceramic or metallic filter which permits water from the well or sump to enter the motor housing whenever the pressure on the outside of the motor is higher than on the inside of the motor. Another method of caring for the expansion and contraction of the coolant is that used by Byron Jackson Pumps, Inc. This method (illustrated in Fig. 4), is very simple and consists of a breather or balance tube on the outside of the motor extending from a level just above the top of the motor to a connection in the bottom of the motor case. Water from the well or sump is permitted to enter the tube at the top and flow freely through the tube to the bottom of the motor housing. Thus, any water that may enter the motor housing remains in the bottom of the housing due to the difference in specific gravity of the oil and water.

In any general comparison of American-made submersible pumps with foreign makes, it may be stated that the efficiencies of the pump portions of the American-made units are higher than those of foreign-made pumps of comparable size. European manufacturers stack the bowls one upon the other and then hold them together with tie rods.

In Europe there has been a tendency to favor 2-pole designs, whereas in the United States, 4-pole designs have been more generally used. However, American manufacturers are beginning to look with favor upon the greater use of 2-pole designs. In the near future 2-pole motors in the larger sizes probably will be made available by American manufacturers.

Since most of the various types described herein have been successfully used in the smaller sizes in thousands of installations throughout the world, there can be no doubt as to the merits of submersible pumps as compared to conventional types. In fact since World War II, the submersible pump for 4-inch wells has been rapidly displacing conventional pumps in some areas. There are also many successful installations of large units in which the wet-stator and oil-filled types have been used.

Table 1 presents a tabulation of the principal submersible motor manufacturers in the United States, England and Europe and the types and sizes of motors offered.

Submersibles Used in Booster Pumping Stations

The use of submersible pumps as booster pumps has become quite common in Southern California. The installations listed in Table 2 have been designed under the supervision of the writer in the office of James N. Montgomery, Consulting Engineer. The submersible pumps listed in this table as having been installed at Henderson and Whitney, Nevada were chosen instead of conventional vertical pumping units because of the frequent high winds in that area which carry blow sand that can cause considerable damage to exposed mechanical equipment. In each case, comparative estimates showed the self-protected submersible installation considerably less expensive than either a vertical or horizontal conventional pump installation when the cost of the necessary protective building was added to the cost of the pump installation.

All submersible pumps listed in Table 2, except those installed at Henderson and Whitney, were chosen because in each case the pumping station was located in a residential area where noise was the important factor.

Table 2 indicates that small subbersible units are relatively expensive but that the cost of 50-hp and larger units is not excessive. It is to be noted that prices of the smaller-size units have recently become extremely competitive. Therefore the prices listed in Table 2 for the smaller sizes are not indicative of current prices. Several manufacturers are now in a position to bid on units up to 150 hp which should have the effect of bring-

CONSTRUCTION of Main Booster Pumping Station, Foothill Municipal District, Pasadena, California.
(Note simplicity of installation of submersible pumps and piping. See pictures of completed station on first page of this article.)

ing prices of submersible pumps closer to those of conventional turbine pumps than has been the case in the past.

The last column in Table 2 gives the cost per horsepower. It should be kept in mind that since the cost includes both the pump and motor, the cost per horsepower is merely a rough means of comparison and is not a true comparison. This is due to the fact that for a given horsepower requirement a high-head low-capacity pump (pump alone) is more expensive than a low-head high-capacity pump because of the greater number of stages required in the bowl assembly.

As to Specifications

The specifications for the pump itself may be essentially the same as for conventional close-coupled turbines.

Because of the wide differences in design of the various makes of submersible motors, a detailed specification which would provide reasonable safeguards and at the same time permit several of the leading manufacturers to bid is something of a problem. The following rather brief specification is being used in the office of James M. Montgomery, Consulting Engineer:

Pump Motors.

(1) The pump motors shall be of the vertical, submersible squirrel cage, 4-pole induction type and shall be of the sizes specified herein, designed for continuous duty under-water operation on 3-phase, 60-cycle, 440-volt alternating current. The motor shall be designed with sufficient starting torque and low starting current for across-the-line starting.

(2) The motor shall be enclosed in an oil-filled or a water-filled housing. Means shall be provided for circulating the oil or water.

Where the motor is enclosed in an oil-filled housing, the housing shall be sealed with a mercury seal, or a mechanical seal. The housing shall contain a reserve supply of oil sufficient for a ten-year period of normal operation and shall be provided with means for maintaining an oil pressure in the motor at least equal to that imposed by the water in the well.

Where the motor is enclosed in a water-filled housing, the motor bearings shall be completely water-lubricated and the amount of external-internal water interchange kept to a minimum by the action of a mechanical seal at the top of the motor. Any difference of pressure between the well water and motor water shall be equalized through the action of a neoprene diaphragm located at the bottom of the motor. The motor shall be designed in accordance with the latest standards of the A.S.A. and N.E.M.A. for the class of installation used.

Any baffling required to divert the water entering the barrel around and past the motor for cooling purposes shall be provided by the manufacturer. The manufacturer shall state whether or not such baffling is required for adequate cooling of the motor. Any baffling required shall be designed so that it will form a part of the pump and/or motor assembly and will not require attachment to the barrel.

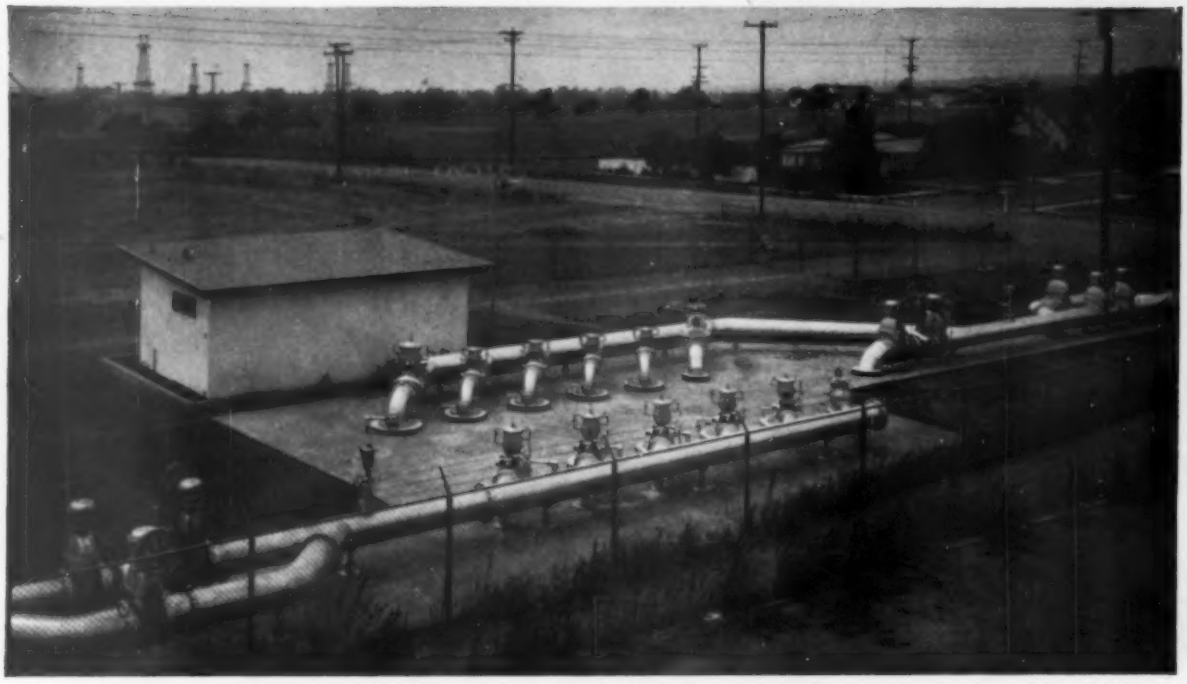
Power Cable to Motor Element.

The power cable to the motor shall be impervious to moisture and shall be polyvinyl chloride insulated cable designed for under-water service. Where the motor leads emerge from the barrel through the suspension flange, they shall be permanently sealed through a water-tight packing or a pothead-type of seal. The cable shall be protected with a steel guard or an armored shield the full length of the cable from the entrance to the motor housing to the suspension flange. The cable size shall conform to the requirements of the California State Electrical Code. A cast or welded steel weatherproof terminal box shall be furnished and installed on top of the suspension flange and provided with plugged conduit outlets on either side of the box. The cable terminations at the terminal box shall be provided with terminal lugs.

In the proposal accompanying the above specification bidders are required to fill out the form—"Data and Information to be Furnished by Bidder" which appears on the next page.

The pump barrel may be specified to be furnished with the pump by the pump manufacturer or may be made a part of the construction contract and installed as part of the piping. The writer prefers the latter method.

The pump may be specified to be furnished with the discharge ell or with only a discharge neck which



BOOSTER Station, City of Inglewood, California.
(Each battery of five submersible pumps supplies a separate pressure zone. Small building houses switchgear.)

would terminate just above the suspension flange.

Installation

Because of the danger of damage to the protective lining in the pump barrel during installation or pulling of the pump, it is a good idea to use a lining which is not easily damaged. A ¼-inch thick cement-mortar lining has been found to be very satisfactory. The usual method is to excavate a wide trench to a level corresponding to the bottom of the suction connection. From this level, the excavation for the barrel is either bored with a cesspool rig or dug by hand. The barrel is then set in place and temporarily suspended from steel beam supports which in turn are supported on jacks or wedges to permit final adjustment. After final adjustment for line and grade, the barrel should be blocked to avoid shifting while the concrete encasement is being placed. Concrete placing must be done rather slowly to avoid floating the barrel. The barrel may be filled with water to help resist the tendency to float. In a multiple pump installation great care should be used in setting the barrels in order to insure perfect alignment.

A small air-release valve should be installed above the suspension flange which will relieve accumulations of air in the pump barrel. The air release valve should be equipped with a check valve, or a separate check valve should be installed to prevent air from being drawn into the barrel under certain conditions through the air release valve.

Where the pumping station is automatic, unattended and equipped with slow-opening pump control valves in the discharge piping, it is a good idea to provide means of automatically stopping the pump if the pump control valve fails to open after the pump builds up the normal discharge pressure. If such protective measures are not taken, the pump would continue to churn and eventually boil the water in the pump barrel if the pump control valve remained closed. Suitable protection can be accomplished either with a time delay relay or with a probe projecting into the pump barrel and connected to a thermostat set to open at a temperature lower than that which would damage the pump and motor.

As shown in the illustrations, a submersible booster pumping station need not be housed unless located in a very cold climate. The electrical controls may be housed in a small building; or, if outdoor switchgear is provided, *all* housing can be eliminated.

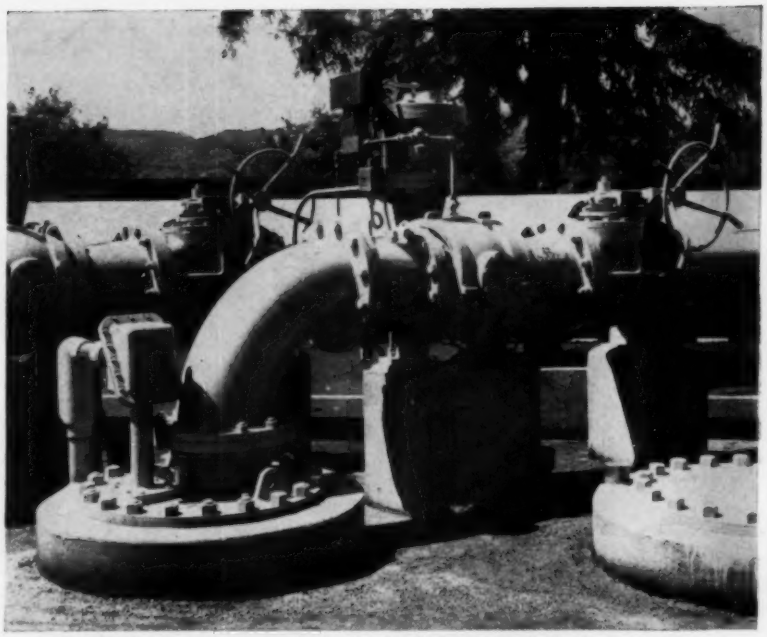
Where a booster pumping station is required in a completely built-up area and where no sites are available, it

Name of Pump Manufacturer.....
Name of Motor Manufacturer.....
PUMP DATA
Pump No.....
Bowl size.....
Number of stages.....
Diameter of shaft (in.).....
Guaranteed Pump Laboratory Efficiencies
At design head (%).....
Maximum efficiency (%).....
Head at max. eff. (ft.).....
Total net weight per unit (lbs.).....
Total shipping weight per unit (lbs.)...
MOTOR DATA
Motor Dimensions:
Length.....
Diameter.....
Guaranteed efficiency at full load rating (%).....
Efficiency:
½ load (%).....
¾ load (%).....
Full load (%).....
Power Factor:
½ load (%).....
¾ load (%).....
Full load (%).....
Starting torque (% of full load torque)
Full load amperes.....
Locked rotor amperes.....
Total net weight per unit (lbs.).....
Total shipping weight per unit (lbs.)...
ATTACH FOLLOWING DATA (3 copies of ea.)
Guaranteed performance curves (showing shut-off condition)
General catalog information describing pumps and motors to be furnished
Method of baffling pump and motor if required to circulate water past motor, if required.

is possible to install submersible pumps in an underground station below the street with outdoor switchgear located in a parkway or other practical location. The usual objection to underground pumping stations is based on the fact that they may be knocked out of service by a break in the piping or from general flooding of the area. This objection is eliminated with submersible pumps.

The writer wishes to express his appreciation for the cooperation of the various pump manufacturers in furnishing information on the various types of submersible pumps that has been assembled in this article.

Ed Note: Lacking the space required, the photograph of the La Canada Submersible Booster Sta. appearing on the front cover could not also be incorporated in the article. Neither could photographs of the Las Vegas or Whitney, Nev., stations be included.



CLOSE-UP of one of the units in the Foothill District Main Booster Station. (On the discharge lines are Davis ball-type pump control valves and Nordstrom plug type shut-off valves.)

Oneonta Dedicates New Water Treatment Plant

A plant of many novel and unique features

With understandable pride Oneonta, N. Y. dedicated its new 4.5 mgd Water Purification Plant on August 9.

Oneonta's new plant, designed by Thomas R. Riddick, New York consulting engineer who briefly described this plant of many unique features and engineering innovations was the recipient of many complimentary remarks from Oneonta's Mayor Hughes, Lothan Feig, Chairman of the Oneonta Board of Public Services, representatives of the technical press, the contractors and others taking part in the dedication ceremonies. The principal dedicatory address was made by a lifetime Oneonta resident, the Hon. J. P. Molianari, Justice of the New York State Supreme Court.

The new Oneonta plant with its many automatic and fool-proof features can be operated normally between 4.5 and 6.75 mgd rates if need be by a single operator. Actually the plant can be operated satisfactorily at 100% design overload at the rate of 9.0 mgd when and if the occasion demands such periodic high rates.

Amongst the unique features is the liberal use of automatically motor-operated butterfly valves at the several points of rate control and the novel method of flow distribution to the 6 filters by a cleverly conceived arrangement of inlet weirs to the six units. The method of filter washing is another unique feature as is the combination of chemicals and method of their pre-mixing and application.

In the last category finely ground (325 mesh) crystalline limestone (calcite) is employed in a unique manner as the agent of alkalinity to produce an optimum pH zone of coalgulation rather than lime or soda-ash. In brief the limestone "dust," the alum solution and chlorine for pre-chlorination are simultaneously fed into a common flash mixing chamber enroute to the point of application to the raw water, where rapid mix with diffused air and subsequent slow mechanical floccolation is provided. The effect is a rapid and uniform floc formation of a structure and weight to produce a water of high clarity on the filters.

In the novel application of the high purity crystalline dust adequate alkalinity of a mild nature is at all times insured without hazard of over alkalinization and damage to floc formation and color adsorption. There appears to be an added plus in the crystalline calcite suspension as a "seed" for rapid uniform floc production as well as a "weighting" agent.

Ed Note: We believe that enough has been said to whet the appetite of the reader for the full story covering the design features of the Oneonta plant and this unique combination of chemicals which is soon to be told in *Water & Sewage Works* by inventor Riddick.

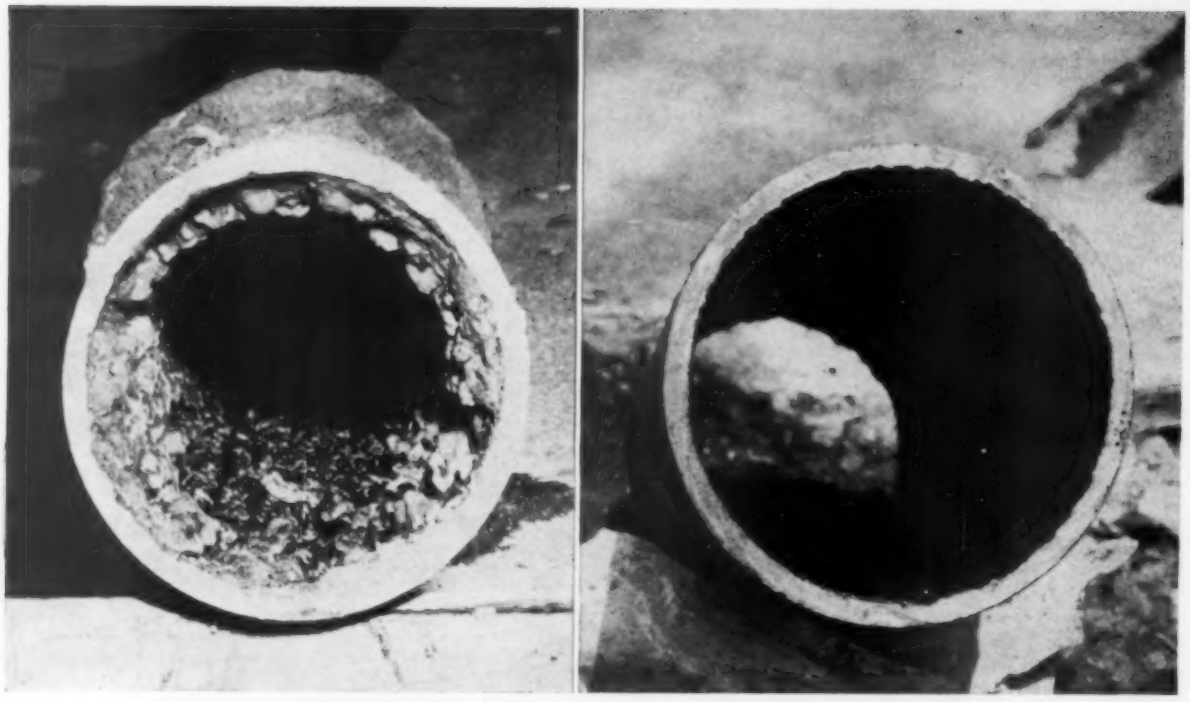


Fig. 1—BEFORE CLEANING and 14 months after cleaning and treatment.

How to
Maintain Pipe Line Coefficient "C"

By the use of hexametaphosphate after water main cleaning

THIS PAPER deals with a fourteen-months' study of maintaining pipe line coefficient in Gorham, Me. Gorham Village, one of the areas supplied by the Portland Water District, for the most part is above the gradient of Sebago Lake, the source of supply. It is necessary, therefore, to pump water into the system by means of a booster pump located at one end of the system; a standpipe located at the opposite end floats on the system. The distance between the booster station and the standpipe is approximately 11,000 feet. The main feed from the booster station to the standpipe consists of an 8-in. water main with a small grid in the center of the system.

Ed. Note: This article is based on a paper presented before the NEWWA and the N.J. Sect. of AWWA with the information amplified and brought up to date since. Published here by permission.

by WM. D. MONIE and H. B. SCALES

Mr. Monie is Chief Engineer and Mr. Scales is Chemist of the Portland Water District, Portland, Me.

In this article the authors recount their experiences with the use of Calgon in a very soft water for maintaining the "C" value of a cleaned main for better than two years.

Situation Before Cleaning

The pumping facilities of the booster station consist of an electrically-driven centrifugal pump with a capacity of 420 gpm, together with a centrifugal pump operated by a gasoline engine for use as a standby in case of power failure. The electrically-driven pump was installed in 1918 and had dropped in efficiency. The District was interested, therefore, in replacing this unit with a modern, more efficient pump.

In investigating to obtain the information necessary to design a proper pump for this location, it was found that the coefficient "C" for the 8-in. line between the booster station and the standpipe varied between 50 and 56. Before proceeding further we felt some action should be taken to reduce the head against which the pump would operate.

Further study revealed that this 8-in. main between the booster station and the standpipe had been cleaned twenty years ago. This fact proves again that it is not feasible to clean a water main without retarding corrosion either by chemical treatment or main lining. To replace this pipe or adequately reinforce the system would be expensive. Inasmuch as Gorham Village is a small isolated portion of the Portland Water District's system, we decided it would make an ideal system to study the effect of chemical treatment after pipe cleaning. Therefore, it was decided to clean a portion of the 8-in. water main and make a careful study for a period of a year to determine the effect of chemical treatment on the pipe coefficient. If this experience disclosed that corrosion could be retarded sufficiently without any other ill effects, we would then proceed in cleaning all of the 8-in. pipe from the booster station to the standpipe, together with some of the 6-in. grid. Ordering a pump replacement was delayed until the end of the study so that the pump design would be proper for the cleaned condition of the main.

Preparation for Cleaning

After due consideration it was decided that sodium hexametaphosphate would be used because of its ease of application and apparent success in other locations. It was also felt that this treatment appeared fool-proof for automatic station operation. If this treatment were not successful, then lime or a combination of lime and metaphosphate was to be tried in the study. The sodium hexametaphosphate used was obtained from Calgon, Inc., and therefore, for simplicity it will hereafter be referred to as Calgon.

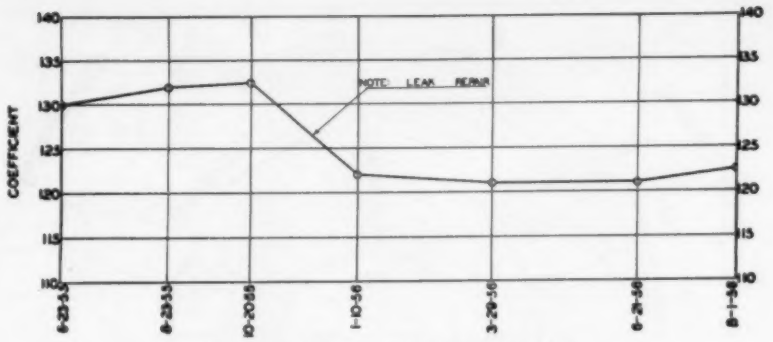


Fig. 2—PIPE line coefficient after cleaning.
Note: "C" Value before cleaning was 56.

For one month prior to cleaning Calgon was added at a dosage rate of approximately 4 ppm. The reason for this prior treatment was two-fold: (1) if possible, to obtain some softening of the tubercles, and (2) to obtain any disintegrating effect that Calgon might have as an aid in the removal of the scale deposit.

Cleaning the Pipe

On June 21, 1955, a 4000-foot section of the 8-in. water line on the discharge side of the booster pump was cleaned by the use of the conventional pipe scraper. It was felt that it would be more difficult to maintain a high pipe line coefficient in this section due to the fact that the pump operates an average of only five to six hours per day, and the remaining time this section of the pipe line is similar to a dead-end condition. The extent of tuberculation before cleaning and the benefits of cleaning and treatment are shown in the before and after conditions in Fig. 1.

In the cleaning operation, only enough pressure was maintained behind the scraper to make it travel no faster than a very slow walk. Before starting the scraper all the hydrants on the section of the main to be cleaned were opened, and all services and grid connections were shut off. As the scraper came to each hydrant its travel was stopped as the water pressure was released at the hydrant. The hydrant was allowed to remain open until the water came fairly clean, then it was closed and the scraper allowed to travel to the next hydrant, etc., until the scraper came out of the opened end of the pipe at the end of the section to be cleaned.

Calgon Application

The scraper was run through the entire section twice. Prior to running the scraper through the second time, one-half pound of Calgon Composition T Glass per thousand feet of pipe was placed behind the cleaner. After the second cleaning the pipe was flushed and put back in service.

The initial rate of feed consisted of 7 ppm of Calgon and 6 ppm of Calgon Composition T Glass. This treatment was continued for approximately two weeks after cleaning, and the T Glass was eliminated and Calgon fed for an additional two weeks at the rate of 9 ppm, after which the Calgon dosage was decreased to 5.5 ppm.

The Calgon Composition T Glass has a zinc base and has the property of laying down a coating much faster than regular Calgon. The authors feel that it is of the utmost importance that Composition T Glass be used immediately after cleaning.

The Calgon was applied by means of a Heavy-Duty Midget Chem-O-Feeder manufactured by Proportioneers, Inc. The pumping station delivery rate was approximately constant, and therefore proper dosage was easily obtained without the necessity of proportional feed.

Table 1 shows a typical analysis of the Portland Water District's water supply as collected in the laboratory. It will be noted from this table that Sebago Lake water is very soft, with a pH of 6.7 and a low total solids content. The calcium content is 4.5 ppm. The iron content is only a trace.

In using hexametophosphate it is necessary that the water supply to be treated shall have a minimum calcium content of 1 ppm for each 4 ppm of Calgon added. This amount of calcium is necessary to combine with the Calgon to form the complicated chemical complex which protects the pipe. If more than 4 ppm of Calgon is added for each part of calcium in the water, the Calgon itself would then be corrosive. If there is not sufficient calcium present for the initial high treatment necessary, it can be added in the form of calcium chloride or lime.

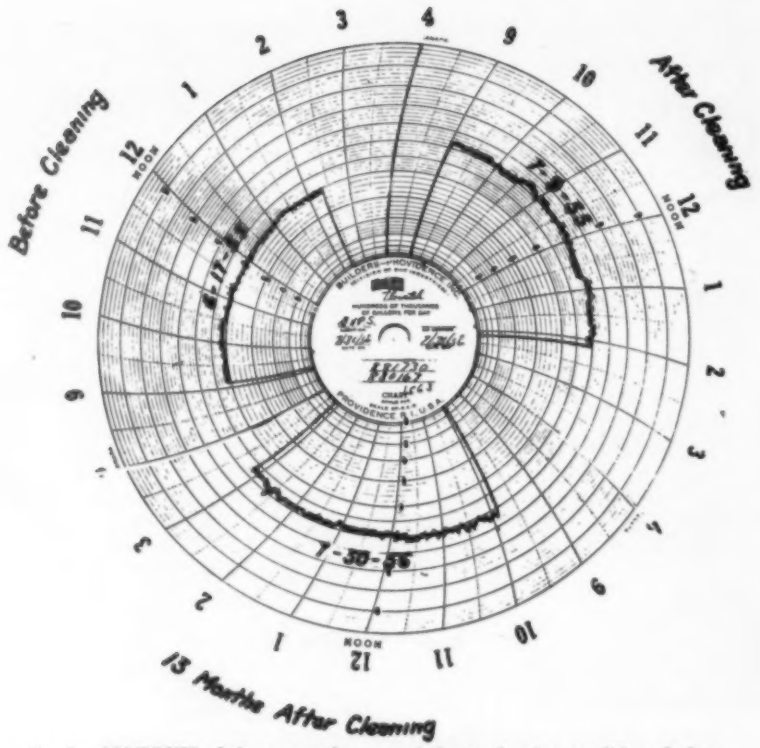


Fig. 3—COMPOSITE of three pumping record charts showing conditions before and after cleaning.

Result of Cleaning

Figure 2 shows the coefficient obtained on the 4000 feet of cleaned main over a period of approximately fourteen months. The original C value before cleaning was 56 and immediately after cleaning it apparently was 130. This coefficient seemed unreasonably high, but a check of the meter, gauges, elevations, and calculations indicated the coefficient to be correct. Subsequent tests taken two months and four months after cleaning showed that the coefficient value was increased to a C of 132½ on October 20, 1955. These results were extremely unreasonable.

It is fairly obvious that there was either leakage or consumption between the two points that were used to determine the coefficient. Samples were taken for iron determination at intervals along the 4000-foot section of cleaned main, and we found a decided drop in the amount of iron present at a point approximately midway in the clean section of pipe. A leak survey of this section of main resulted in finding a joint leak where the pipe is in a filled portion of the road approximately eleven feet deep. After repairing the leak, the coefficient dropped to a C value of 121 to 122. This was reasonable, and this coefficient has been maintained to date.

The tests to determine the coefficient were made at 2:00 a.m. so as to eliminate as much as possible excessive usage between test points. Some fluctuation in the computed C value is to be expected because of the short test section. A difference of one-quarter of a pound on a gauge reading will make a few points difference. On each date shown on Fig. 2 two tests were made and the results averaged. The average results are shown on this graph. As mentioned, the coefficient of this test section prior to cleaning was 56.

Figure 3 is a composite of three separate flow charts, one showing the pumping rate prior to cleaning the test section of the main, one showing the pumping rate three weeks after cleaning, and the third showing the pumping rate one year after cleaning. It will be noted that the pumping rate before cleaning was approximately 600,000 gpd; immediately after cleaning approximately 700,000 gpd; and the pumping rate after one year remained at 700,000 gpd, showing that the coefficient of the test section of cleaned pipe has been maintained.

Study of Iron Pickup

To check the effectiveness of the Calgon treatment in addition to the coefficient test above described it seemed essential to keep a close watch on the iron pick-up and the metaphosphate residual. The pick-up of iron would be an indication of the protection afforded the pipe by the addition of Calgon. If a complete protective coating were laid down on the pipe there would be no pick-up in iron in this clean section of main.

As previously stated, the pump normally operates from 9:00 a.m. to 2:00 p.m., and for the intervening nineteen hours the Village is supplied from the standpipe. Samples were collected for iron determination from three points; one at each end of the cleaned section 4000 feet apart, and one near the standpipe 7000 feet away from the cleaned section of pipe. These samples were collected just prior to starting the pump.

Figure 4 shows in the upper graph the ppm of Calgon feed from July 1, 1955, to the middle of August, 1956. The lower graph shows the average iron pick-up per hour in ppm in the sample collected nearest to the pumping station. As shown in Table 2, the iron content in the sample increases the longer the water remains in contact with the pipe in this dead-end section. Therefore, to obtain the amount of iron shown in Fig. 4, the iron content of the sample was divided by the number of hours between the time the pump was shut off and the sample taken.

Note the high initial rate of Calgon, as previously stated, which was then

TABLE 1

Chemical Analysis of Portland Water (Lake Sebago)

	ppm
Chlorides	2.4
Nitrates	0.05
Nitrites	TR.
Free Ammonia	0.028
Albuminoid	0.074
Required Oxygen	2.8
Dissolved Oxygen	11.1
Hardness	14.0
Alkalinity	5.4
pH	6.7
Carbon Dioxide	1.0
Iron	TR.
Total Solids	27
Loss on Ignition	11
Silica (SiO_2)	6.0
Aluminum (Al)	TR.
Sodium (Na)	1.7
Potassium (K)	1.6
Calcium (Ca)	4.5
Magnesium (Mg)	1.0
Manganese (Mn)	0
Iron (Fe)	TR.
Sulphates (SO_4)	6.0
Carbonates (CO_3)	6.0
Fluorides	0

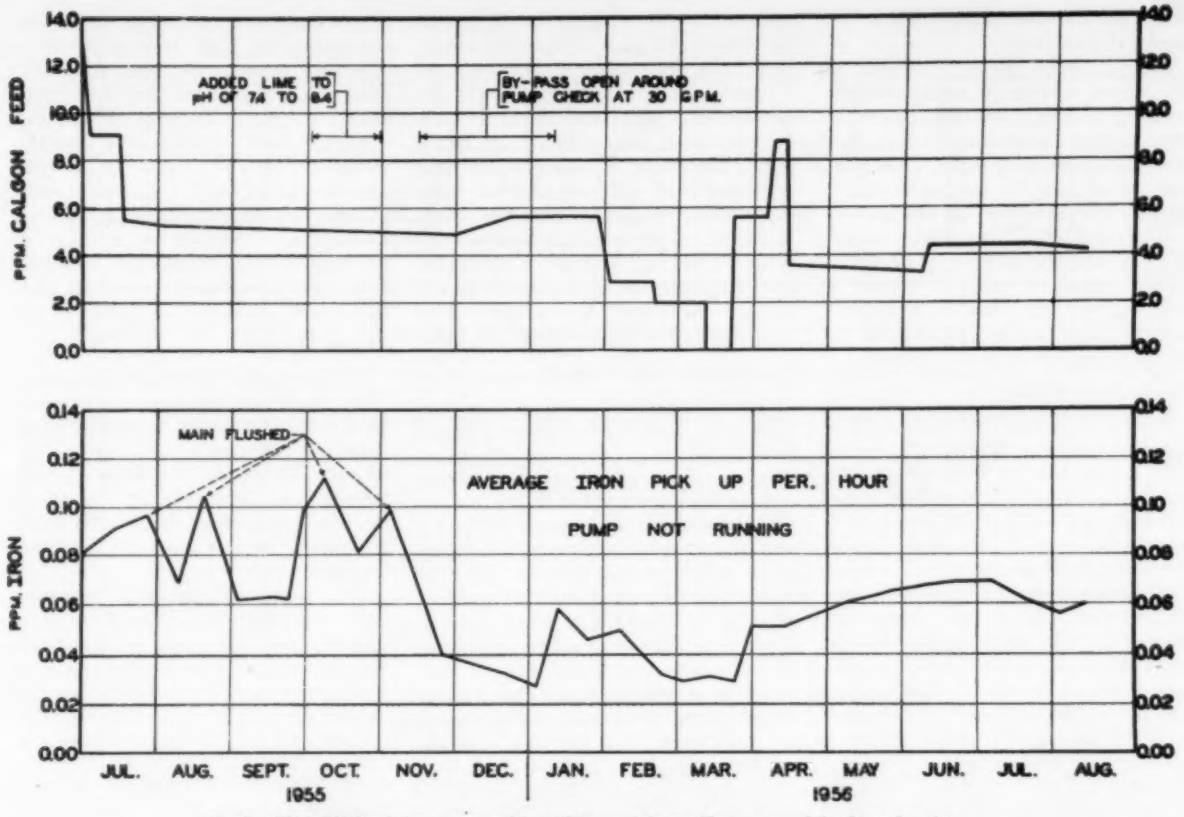

PPM. CALGON FEED
ADDED LIME TO pH OF 7.4 TO 8.4
BY-PASS OPEN AROUND PUMP CHECK AT 30 G.P.M.
PPM. IRON
MAIN FLUSHED
AVERAGE IRON PICK UP PER. HOUR
PUMP NOT RUNNING
JUL. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG.
1955
1956

Fig. 4—CALGON feed (upper graph) and iron pick up (lower graph) after cleaning.

reduced to 5 to 6 ppm until February, 1956. The reason for continuing the relatively high Calgon feed in excess of 5 ppm was to hold in solution the iron pick-up at that time, and thereby preventing oxidation of the iron and red water complaints. Note too that the iron pick-up was high from July to early November.

It was anticipated that the iron content would be high immediately after cleaning, due possibly to corrosive products left in the pipe and which were not removed in the flushing process. However, as noted on the chart, periodic flushings made only temporary improvements in the iron pick-up. The lower iron content which persisted for practically the whole of September was due to a leaky check valve on the pump discharge. When this was corrected the iron content went back to its previous level.

Lime Added

After repairing the check valve and our iron content returned to a high level, it was decided to add lime in addition to Calgon to see if additional calcium to react with the Calgon would be of any benefit. The addition of lime with the increase in pH should also decrease the corrosion of the iron. It was realized that it would be possible to greatly reduce the corrosion of the pipe by increasing the pH to around 9.5, just above the saturation point. However, if possible, we did not want to add lime as the prime corrosion inhibitor because of the unreliability of uniform lime feed in an unattended station. As noted on Fig. 4 only a slight reduction in iron was observed while the lime feed was carried on during the month of October.

TABLE 2

Data on Iron Pick Up

Time	pH	Iron
10-24-55		
3:30 P.M.	8.3	Trace
5:30		0.1
7:30		0.3
9:30		0.5
11:30	8.0	0.6
10-25-55		
1:30 A.M.		0.8
3:30		1.1
5:30		1.3
7:30	8.1	1.4
8-13-56		
3:30 P.M.	6.9	Trace
5:30		0.2
7:30		0.3
9:30		0.4
11:30	6.9	0.5
8-14-56		
1:30 A.M.		0.7
3:30		0.8
5:30		0.9
7:30	6.9	1.2

NOTE: Each Day Pump Ran from 10:00 A.M. to 3:30 P.M.
CALGON FEED 10-24-55 4.3
CALGON FEED 8-13-56 4.5

Noting the reduction in iron content in September while the check valve was leaking, it was decided to install a 1-in. by-pass around the check valve on the discharge side of the pump. While operating the by-pass so that after the pump was shut off a constant flow was maintained at approximately 30 gpm, there was a drop in the iron pick-up.

It is believed that this reduction in iron content was due to: (1) the water was not in contact with the iron as long a time, and (2) additional protective film was deposited due to the velocity increase in the pipe. Note in Fig. 4 that when the by-pass was closed the iron content increased, but did not, for the remainder of the test period, approach the iron pick-up during the early months.

The increase in iron pick-up from May 1, 1956 on, was believed due to the higher water temperature. The decrease in iron pick-up in late July and early August was believed due to a decrease in water temperature

caused by the cool weather which occurred at that time.

Table 2 shows the iron pick-up of the cleaned section of main near the pumping station, starting from the time the pump was shut down at 3:30 p.m. and continuing until 7:30 a.m. One set of samples was collected in October of 1955 and the second set in August, 1956. The pH on October 24-25 reflects the addition of lime during the month of October. It will be noted, in each case shown in Table 2 that the iron pick-up showed an increase at every two-hour interval.

Calgon Feed Varied

Figure 5 shows the Calgon feed and iron determination for the period from the middle of February to the middle of April, 1956. The upper graph shows the Calgon feed during this period in parts per million. The lower graph shows the actual iron determination of samples collected near the pump station just prior to starting the pump. The sampling point is the same point from which the samples were taken as shown on Fig. 4. Note that the water temperature remained at 37°F. during this entire period.

During the middle part of February the Calgon feed was 3 ppm, and the iron content of the water was 1 ppm. On February 20th the Calgon feed was reduced to 2 ppm and maintained at this rate until March 12th. During this period the iron content of the sample collected just prior to the starting of the pump, after remaining in the main for approximately nineteen hours, decreased to 0.6 ppm. Then for a ten-day period no Calgon was added, and the iron remained at 0.6 ppm.

It was believed that the decrease in the iron content from 1 ppm to 0.6 ppm was caused by the fact that the 2 ppm of Calgon was not sufficient to hold in solution all of the iron coming from the main, and as a result a portion of this iron was oxidizing and precipitating in the main. Also, it was believed that the reason the iron content remained at 0.6 ppm during the ten-day period, when no Calgon was added, was due to the metaphosphate coating on the pipe. Apparently it is possible to discontinue the feed of Calgon for short periods of time without losing all of the benefit from the treatment. This experiment was not continued for a greater length of time because without treatment scale or tubercles would begin to build up in the pipe line.

To determine whether or not the drop in iron content was due to oxidation of part of the iron removed from the main with treatment of 2 ppm of Calgon, Calgon was added at the rate of 5.5 ppm. With this treatment, the iron content returned to 1 ppm. Calgon feed was then increased to 8 ppm, and the next iron determination was found to be 1 ppm. Therefore, it was obvious that for conditions existing at that time a treatment of 3 ppm was the minimum for proper control. Later in the year, as the temperature of the water increased and the iron content of the sample increased, the Calgon dose was changed to approximately 4 ppm.

Iron Content with Pump Running

To determine the amount of iron pick-up in the 4000 feet of cleaned main while the pump was running, samples were taken on the suction side of the pump and at the end of the cleaned main farthest from the pump station. It was necessary to concentrate 1500 ml samples in order to make this determination. Pumping at the rate of 700,000 gpd, the iron pick-up was 0.023 ppm, which calculates to an iron loss of 0.012 lbs. per year per foot of pipe. Even this loss is insignificant compared to the benefit of maintaining the carrying capacity in the pipe. It is possible that with the new pump installations, which will provide a much longer period of flow, greater protection against corrosion will be obtained, with a corresponding decrease in iron loss.

Residual Metaphosphate

On Fig. 6 the clear circle shows the amount of metaphosphate added, while the circle with the cross shows the metaphosphate residual on samples taken near the pump station. Again, in all cases shown on this figure the water sample which had remained for approximately nineteen hours in the pipe line, under dead-end conditions, was collected just before starting the pump. The difference between the amount of Calgon and the residual could possibly be considered as the metaphosphate demand which we assume deposited on the pipe. Note on the samples, immediately after cleaning the main, the high metaphosphate demand, which gradually decreased for a four-months' period after starting treatment. This fact again discloses the importance of a relatively high initial rate of feed immediately after cleaning.

As previously stated, the test section of pipe was purposely chosen so that the experiment would be carried out under the worst possible conditions. Under those conditions the amount of chemical feed would necessarily be higher to maintain the pipe line coefficient than under conditions of continual flow in the pipe line. The comparatively high iron pick-up in this test section disclosed that 100 percent protection was not being obtained from the Calgon. Therefore, it was necessary to add more than the normal amount of Calgon feed to prevent oxidation and red water complaints. Under conditions of continuous flow it should be possible to decrease the rate of chemical feed and obtain greater protection with the corresponding reduction in iron pick-up.

Benefit Studied

To determine the effect of Sebago Lake water without special treatment on a piece of cleaned 8-in. pipe taken from the Gorham system, and to determine whether or not there was any benefit from the treatment, other than the dispersing effect of the iron being picked up from the pipe, the following test was made:

The piece of pipe approximately eight feet long, which had been removed from the main to insert the cleaner, was similar in all respects to the cleaned main since the cleaner had passed through it twice. Through this section of 8-in. pipe Sebago Lake water was passed without chemical treatment. Water was allowed to flow through this pipe for a five-hour period each day, and the water allowed to remain without flow under pressure for nineteen hours to simulate as closely as possible conditions which existed at the sampling point on the cleaned section of main.

Samples were taken from this test specimen each day after the water remained in the pipe for a nineteen-hour period without flow. The iron content of these samples averaged about 4 ppm and the water had the typical appearance of red water. Therefore, this test showed that although the treatment was not providing 100 per cent protection, approximately 50 to 75 per cent protection was being obtained from the treatment while also maintaining the carrying capacity of the pipe.

This test piece of pipe was capped with mechanical joint caps which were easily removed to inspect the interior of the pipe. After only two weeks, considerable corrosion was observed along with the start of scale buildup.

Additional Data

Since the above data were assembled an additional year's study is now completed and the authors feel that this paper will be of greater interest if results to July 1957 are added. With this supplement the paper will therefore cover a two-year study by the Portland Water District on the use

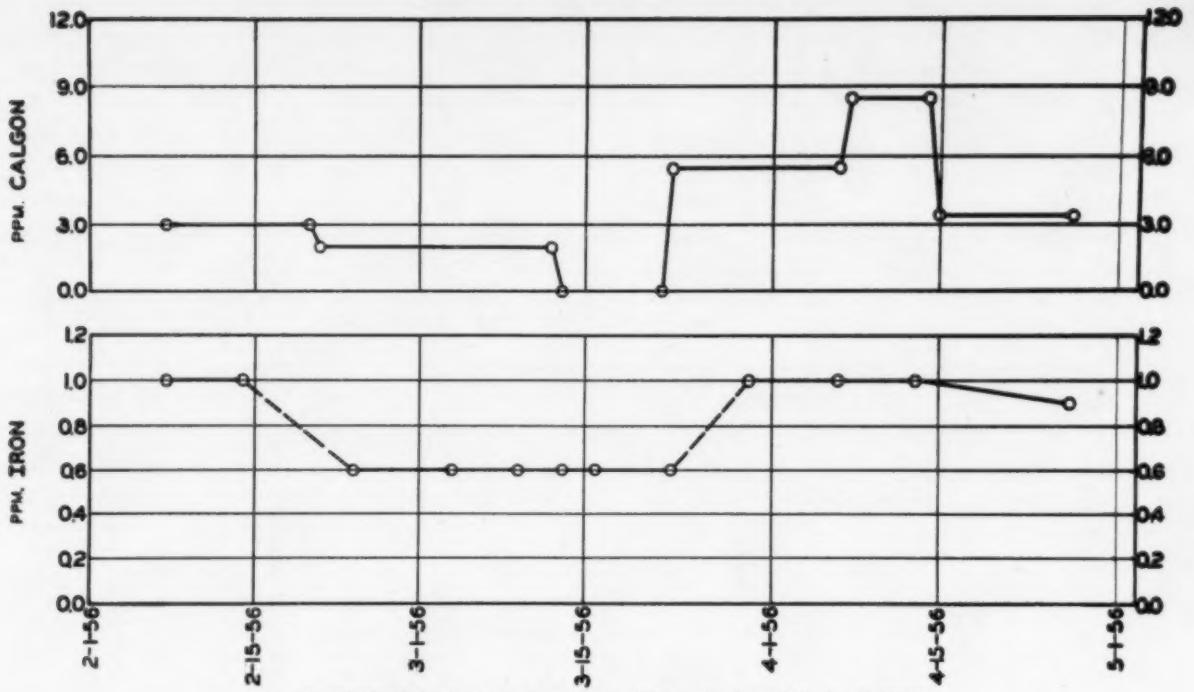


Fig. 5—CALGON feed (above) and iron pick up (below) Feb.-April 1956
Note: Water temperature was 37°F throughout the period.

of glassy phosphate to maintain pipe line coefficient after main cleaning.

Main Cleaning Extended

Encouraged by the result of the first year's study the remaining 7,000 feet of 8-in. pipe line between the pump station and the standpipe were cleaned. This main was cleaned in three sections, starting on August 14, 1956 and completed on Aug. 17, 1956. The cleaning method was the same as that used in cleaning the first 4,000 foot section.

The peptizing effect of Calgon on the old deposit was quite evident. The material removed from the pipe in the cleaning process, as it came out of the main, did not collect in a pile but ran off with the water discharging from the pipe.

After cleaning the remainder of the 8-in. pipe line to the standpipe, regular Calgon and Calgon Composition T Glass were added in the same proportion and manner as added after cleaning the original 4,000 foot section of main near the pump station.

The coefficient of this 7,000 foot section of main was 56 prior to cleaning and 112 after cleaning; the average "C" value for the whole line is 115 and the pumping head has been reduced by 100 ft or 43 psi.

Also, on September 15, 1956 two new automatically operated electric driven pumps were put into service as replacement for the old electric driven pump. The smaller of the two new pumps carries the pumping load and delivers 200 gpm. Thus, the pumping time has been increased from an average of 5 to 6 hours per day to an average of 12 to 14 hours per day. Furthermore, the time between pump operations has been reduced from 19 hours to a maximum of about 7 hours. The decrease of pump capacity, of course, means a decrease in flow velocity.

As before, a careful record was maintained on iron pick-up, metaphosphate residual and pipe line coefficient. Table 3 gives the results of iron and metaphosphate determinations in samples collected from points as shown between the pump station and standpipe. Samples taken through Sept. 14, 1956 were taken just prior to the starting of the pump, as was the practice in the first year's study. Samples after Sept. 14, 1956 are under different conditions, i.e., due to the automatic pumping the samples were collected three hours after the pump started.

Test results have disclosed that with the longer pumping time there has been no change in the rate of iron pick-up. Due to the shorter period between pump operations the maximum iron content is decreased but the rate of iron pick-up per hour in the original cleaned section of pipe, while the pump is not operating, is the same as before the change in pumps. Likewise, while the iron content of the water at the end of the 4,000 foot section of pipe originally cleaned has increased to 0.1 ppm with the 200 gpm pump in operation, the iron pick-up still calculates to about 0.023 ppm and the iron loss per year per foot of pipe remains at 0.012 lb.

Table 4 gives the results of coefficient tests made on various sections of the 11,000 feet of 8-in. cleaned pipe. Sect. No. 1 is the original 4,000 foot section; Sect. No. 2 is the next 3,000 foot toward the standpipe; Sect. No. 3 is the remaining 4,000 feet to the standpipe. No. 4 is the complete 11,000 foot section from the pump station to the standpipe.

It is of interest to note that through June 21, 1957 there has been no loss in coefficient in the first 4,000 foot section of pipe cleaned on June 21, 1955. Thus, the coefficient on this section of pipe has been maintained without loss over a two-year period following cleaning. The coefficient of Section No. 2 has been maintained without loss over the ten-month period since cleaning.

Section No. 3, closest to the standpipe, shows a drop in coefficient from the original 110 after cleaning to 90 in a ten-month period. It is also noted that the major drop occurred in the last two months.

The overall 11,000 feet of pipe shows a drop in ten months from a coefficient of 115 to 110. This drop

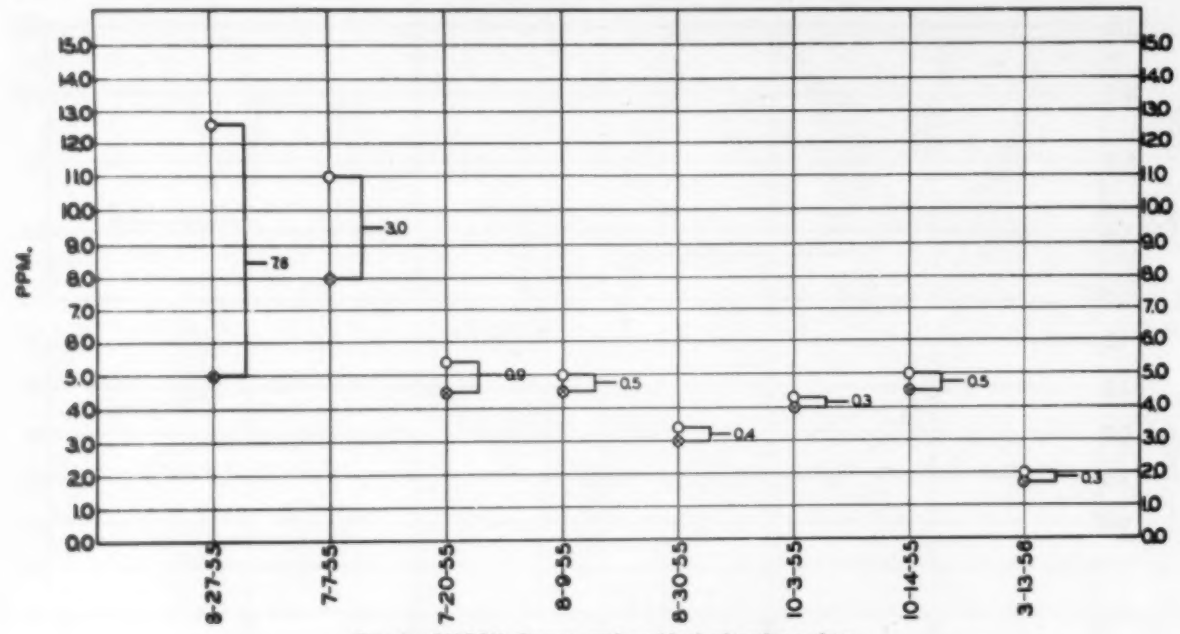


Fig. 6—CALGON dosage and residual phosphate data.
Circles indicate ppm hezametaphosphate added; cross in circle indicates ppm metaphosphate residual.

is due to the loss which has occurred in the 4,000 foot section near the standpipe.

Practically all of the water pumped passes through the first two sections of cleaned main from the pump station to the grid system near the center of the village. Then the water fans out in the grid system with resulting decrease in velocity in the last section of cleaned main to the standpipe. Therefore, there is less chemical passing through the last section of cleaned pipe.

Furthermore, when the pump is not operating water passes from the standpipe into the system. Then when the pump operates the water in the pipe line which came from the standpipe must be repumped into the standpipe before newly treated water passes through the pipe. Thus the pipe line closest to the tank receives the least amount of fresh chemical.

The warmer the water the more aggressive it becomes and therefore the more iron will be removed from the pipe. Also, the warmer the water the greater will be the reversion of metaphosphate to orthophosphate.

Referring again to Table 3 it is noted that in June the iron content dropped to 0.3 ppm in the last section although the temperature increased to 70°F. Also, note that the metaphosphate residual was 1.0 ppm. Apparently there was not sufficient metaphosphate residual to hold all of the iron in solution and some of the iron was building up on the pipe line causing a decrease in coefficient on this last section.

This is further substantiated in the fact that when the Calgon feed was increased from 2.5 ppm to 3.5 ppm the metaphosphate residual at the sampling point near the standpipe increased to 2.2 ppm and the iron content increased to 0.45 ppm.

This section of pipe line closest to the standpipe will be closely watched to determine the effect of maintaining a metaphosphate residual in excess of four times the iron pick-up. We are hopeful from past results that the decrease in coefficient will be greatly retarded.

TABLE 3
Data on Iron Content 8/24/56 to 7/2/57

Date	Pump Operation	Iron in ppm: Near Pump Sta.	Iron in ppm: 4,000 ft from Pump Sta.	Iron in ppm: 10,500 ft from Pump Sta.	Calgon Feed ppm	Meta-phosphate Residual	Water Temp. °F
8/24/56	P.N.R. (18)	1.2	1.6	1.0	15		68
8/31/56	P.N.R. (18)	1.0	1.6	0.7	12		64
9/14/56	P.N.R. (18)	1.0	1.2	0.6	8		65
9/25/56	P.R. (3)	Trace	0.3	0.7	5	4.0	64
10/18/56	P.R. (3)	Trace	0.3	0.7	5		56
11/29/56	P.R. (3)	Trace	0.1	0.6	3.5	2.5	48
1/10/57	P.R. (3)	Trace	0.1	0.5	3.5		38
2/28/57	P.R. (3)	Trace	0.1	0.5	2.5		36
4/4/57	P.R. (3)	Trace	0.1	0.6	2.5		40
6/5/57	P.R. (3)	Trace	0.05	0.3	2.5		52
6/20/57	P.R. (3)	Trace	0.1	0.25	2.5		66
6/25/57	P.N.R. (7)			0.3	2.5	1.0	70
7/2/57	P.N.R. (7)			0.45	3.5	2.2	70

P.N.R. (18) Pump off 18 hrs. when sample taken.
P.R. (3) Pump running 3 hrs. when sample taken.
Metaphosphate residual on sample collected 10,500 feet from pump station.

Summary and Conclusions

At the present time the authors believe that the conclusions reached at the end of the first year's study still hold. These were:

1. By means of pipe cleaning the pipe line coefficient of 56 was raised to 120.
2. By chemical treatment with sodium hexametaphosphate this coefficient was maintained without loss, during the period of 26 months.
3. No red water complaints were received at any time after pipe cleaning.

4. The cost of chemical treatment as compared to the carrying charges on the cost of either water main replacement or reinforcement was small.

5. The labor cost of chemical treatment is minor, as it is necessary for a man to check the pumping station each day, and it requires only a few minutes of his time to prepare the chemical.

6. While complete protection against corrosion was not obtained, the carrying capacity of the pipe line was maintained during the period following main cleaning when usually the rate of drop in coefficient is at its greatest.

7. As time goes on in all probability there will be some decrease in carrying capacity. If the coefficient of this pipe line does not drop below a value of 100 in ten years, we believe the treatment will have been successful.

TABLE 4
Coefficient "C" in Pipe Line

Date	4,000 ft Section No. 1	3,000 ft Section No. 2	4,000 ft Section No. 3	11,000 ft Overall No. 4
8/1/56	121	60*	50*	56*
9/6/56	121	115	110	115
4/4/57	120.5	112.5	103	112
6/21/57	121	116.5	90	110

* Before main cleaning

8. We are all satisfied with the result to date on the first 7,000 feet of pipe cleaned from the pump station and feel that the information gained in this study will enable us to better control the last 4,000 foot seciton.

9. Inasmuch as there is no one method of water treatment that will cure all ills everywhere, the authors strongly advise a pilot plant study under actual operating conditions before going to expense on any contemplated change in treatment.

Acknowledgment

The authors wish to express their appreciation to Mr. Herman Burgi, Jr., Treasurer and General Manager of the Portland Water District for his helpful cooperation and advice during the experiment, and also to the Trustees of the Portland Water District for their support of the project. We also wish to express our thanks to Mr. J. P. Hennings, Superintendent of the Portland Water District and his efficient crew for their excellent job of cleaning the pipe.

Suggested Procedure

Whenever posible, Calgon should be used at a feed of from 2 to 4 ppm for as long a period as possible before proceeding with water main cleaning. This prior feed of Calgon has a tendency to soften the tubercles and is an aid in dispersing the sediment removed from the pipe so that it does not as readily build up and form a plug in front of the pipe cleaner.

Prior to sending the pipe cleaner through the pipe on the last cleaning, one-half pound of Composition Calgon T Glass for each thousand feet of pipe to be cleaned should be inserted behind the cleaner.

After cleaning the pipe it is advisable to immediately start the Calgon treatment as follows:

A. Regular Calgon and Calgon T Glass should be applied in the usual manner in combination of 7 ppm of Calgon T Glass and 8 ppm of regular Calgon. These two chemicals can be mixed together in the same drum and fed through a common pump. However, it must be borne in mind that the combination feed of Calgon and Calgon T Glass should not exceed four times (in ppm) the content of calcium present in the supply. In the event additional calcium is needed, this should be added to the water prior to the addition of Calgon, either in a form of calcium chloride or lime.

B. The above-mentioned combined feed should be continued for a two-weeks' period, after which the Calgon T Glass feed can be eliminated. After the elimination of the Calgon T Glass, the feed will then consist of 8 ppm of regular Calgon. This feed of regular Calgon should continue for a three-weeks' period. After this period, the Calgon feed should be reduced at the rate of 2 ppm each week until the proper final amount of Calgon feed is reached; which is as follows:

1. The Calgon as a final feed should never be less in parts per million than that required to maintain a metaphosphate residual four times the amount of iron in the water sampled at the end of the cleaned portion.

2. Where, and if, there is continual flow of water in the cleaned mains, the final Calgon treatment normally is approximately 2 ppm. If the water stands without flowing in any portion of the cleaned main, it will be necessary to test for and determine how much additional Calgon feed is necessary.

The Calgon T Glass material has a zinc base with the property of forming a rapid coat on the interior surface of the pipe. Therefore, in order to hold the initial coefficient obtained after cleaning, it is important to use this material immediately after the cleaning operation.

FS&IWA Convention Exhibitors

The following members of the Water and Sewage Works Mfgr's. Assn. will exhibit at the convention of the Federation of Sewage and Industrial Wastes Assn's. to be held at the Hotel Statler, Boston, Mass., October 7-10.

Airkem, Inc.
American City Magazine
Armco Drainage & Metal Products
B-I-F Industries
Combustion Eng. (Raymond Div.) Inc.
Dorr-Oliver, Inc.
Engineering News-Record
Inertol Co., Inc.
Infilco Inc.
Jeffrey Manufacturing Co.
Johns-Manville
Kasbey & Mattison Co.
Link-Belt Co.
Lock Joint Pipe Co.
Nichols Eng. & Research Corp.
Public Works Publications
Roots-Connersville Div., Dresser Industries
Vapor Recovery Systems Co.
Walker Process Equipment, Inc.
Wastes Engineering
Water & Sewage Works Magazine
Western Machinery Co.

Texas Mayor Now Full Fledged Plant Operator

We believe that Mayor W. D. Curties of Vernon, Texas, is the first Mayor in the country to come up for and pass the examinations for certification as a qualified operator of both water and sewage treatment plant. Mayor Curtis has received "Certificates of Competency" as a water works operator, and as a sewage work operator, from the Texas State Dept. of Health.

A Nomograph For the Determination of Concentric Orifice Diameters

by ALEXANDER GOLDSTEIN

Mr. Goldstein is Senior Mechanical Engineer, West-Southwest Sewage Treatment Works, Sanitary District of Chicago.

THIS IS A SECOND article on the determination of orifice diameters for fluid flow*. The phenomenal growth of the instrument industry with its innumerable fluid flow measurement applications provides ample testimony to the frequent necessity that size of the diameters of primary metering elements have to be made.

The vast amount of experimental work everywhere at its zenith requires orifice determinations so that flow measurements can be obtained for the gathering of vital information. There is little need to further emphasize the importance of improved methods for solving the orifice diameter problem.

* Ed. Note: The previous article appeared on p. 515 of the Nov. 1956 issue of *Water & Sewage Works.*

Graphic Solution

It is often advantageous to solve graphically a recurring mathematical problem. When such a method is accurate, rapid and convenient it is of considerable value. This article contains a nomograph, for the graphic solution of the orifice diameter problem. Its accuracy is well within one per cent of arithmetical computation and it, therefore, represents a serious attempt to solve the problem. It requires only that these basic factors be known: Rate of flow, differential pressure drop across the orifice, pipe diameter, and density (or specific volume) of the flowing medium. The factors must be in the units indicated on the graph.

The mathematical basis for the nomograph does not follow directly from the normal equation evaluating the diameter. The equation must be put in a suitable form. Since the transformation was found interesting and may be of some value it is presented here.

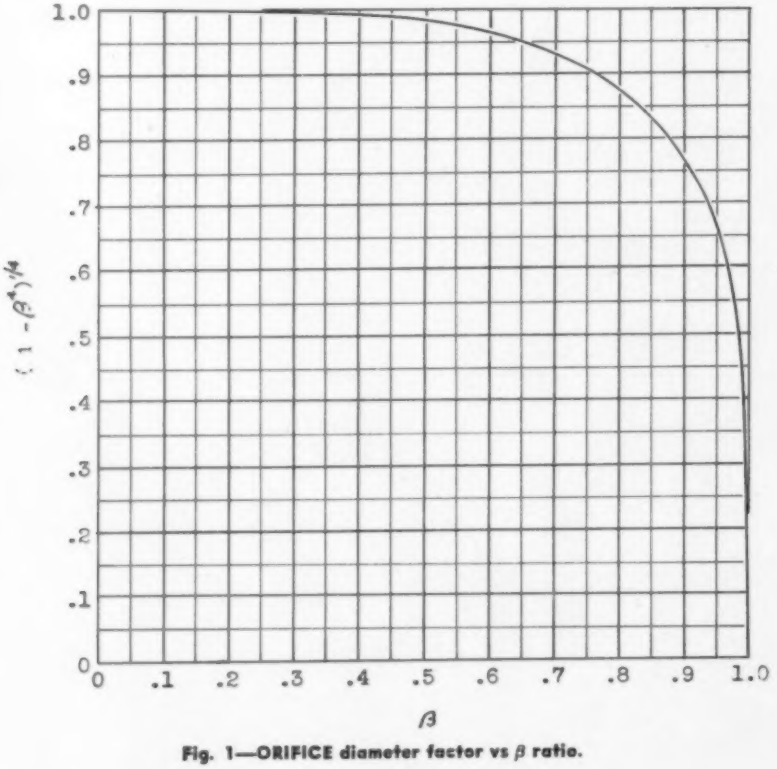


Fig. 1—ORIFICE diameter factor vs β ratio.

Symbols

The following symbols are use:

- A = the area of the orifice in square feet
- β = the ratio d/D, orifice diameter to pipe diameter
- C = the orifice coefficient not including the velocity of approach factor
- d = the orifice diameter in inches
- D = the internal pipe diameter in inches
- g = the acceleration of gravity, 32.16
- G = gallons per minute
- h = the orifice differential in inches of water column
- H = the orifice differential in feet of flowing fluid column
- M = pounds per minute
- q = cubic feet per second
- Q = cubic feet per minute
- ρ = density in pounds per cubic foot
- v = specific volume in cubic feet per pound

Basic Equation

The basic orifice equation for fluid flow is

$$q = CA\sqrt{\frac{2gH}{1-\beta^4}} \qquad (1)$$

In order to use a time interval of one minute and water column differentials, Equation (1) is converted into the following

$$Q = 1096.4\,CA\sqrt{\frac{2gH}{1-\beta^4}} \qquad (2)$$

Introducing into Equation (2) the orifice diameter and giving **C** a val-

ue of 0.61, the following equations are obtained:

$$Q = 3.65\ d^2 \sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (3a)$$

$$M = 3.65\ d^2 \sqrt{\frac{h/v}{1-\beta^4}} \qquad (3b)$$

$$G = 27.29\ d^2 \sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (3c)$$

Limiting the discussion to equation (3a)

$$d = \sqrt{Q}\left(13.32\frac{h}{\rho} + \frac{Q^2}{D^4} \right)^{-\frac{1}{4}} \qquad (4)$$

The value of **d** can now readily be computed by introducing the numerical values of all the symbolic quantities.

Transformation Of The Equation

In order to make a nomograph for a graphic and rapid determination of **d**, Equation (4) is not altogether suitable and must be put in a more appropriate form. This is done in the following manner:

Equation (4) is first rearranged to read

$$d = .5234\ Q^{\frac{1}{2}}\left(\frac{\rho}{h}\right)^{\frac{1}{4}} \left(1 + 0.0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}} \qquad (5)$$

The factor $\left(1 + 0.0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}}$ is expanded in accordance with the binomial theorem, resulting in the identity

$$\left(1 + .0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}} = 1 - .0188\frac{\rho Q^2}{hD^4} + .00088\frac{\rho^2 Q^4}{h^2 D^8} \qquad (6)$$

If the third and following terms could be discarded under all conditions as being very small and not significant, the production of the nomograph would now be assured. But this is not possible since these terms are often appreciable.

Returning to Equation (3a) and solving again for **d**,

$$d = .5234\ Q^{\frac{1}{2}}\left(\frac{\rho}{h}\right)^{\frac{1}{4}}(1-\beta^4)^{\frac{1}{4}} \qquad (7)$$

The expression $(1-\beta^4)^{\frac{1}{4}}$ has significance in that it shows the change in orifice diameter for flow in pipes compared to discharge from a plenum chamber.

Comparing Equations (5) and (7)

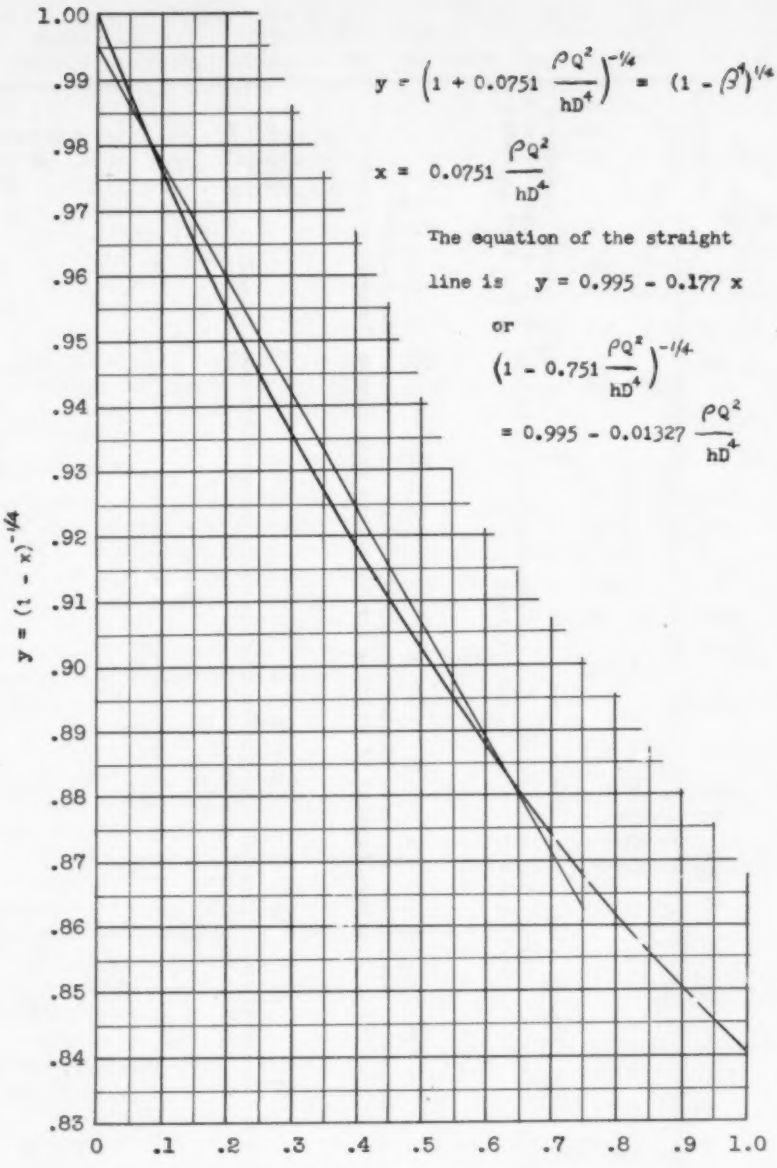


Fig. 2—PLOT of $y = (1 + x)^{-\frac{1}{4}}$ vs x and its straight line approximation.

$$(1 - \beta^4)^{\frac{1}{4}} = \left(1 + .0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}} \qquad (8)$$

A curve, Fig. 1, is drawn having $(1-\beta^4)^{\frac{1}{4}}$ ordinates and β abscissas. Inspection of the curve shows that for values of β up to 0.80, $(1-\beta^4)^{\frac{1}{4}}$ and, therefore, its identity

$$\left(1 + .0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}}$$

has values ranging from 1.00 to 0.87. Since the nomograph is for values of β not in excess of .80, values of

$$\left(1 + .0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}}$$

lower than 0.87 need not be considered.

Now let $y = \left(1 + .0751\frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}}$

and

$$x = .0751\frac{\rho Q^2}{hD^4}.$$

A second curve, Fig. 2, is drawn having y or its equivalent $(1+x)^{-\frac{1}{4}}$ ordinates and x abscissas. A straight line is drawn between the points $x_1\ y_1 = (0)\ (.995)$ and $x_2\ y_2 = (.65)\ (.88)$ approximating all values of the curve with a departure at all points of less than one percent. The equation of

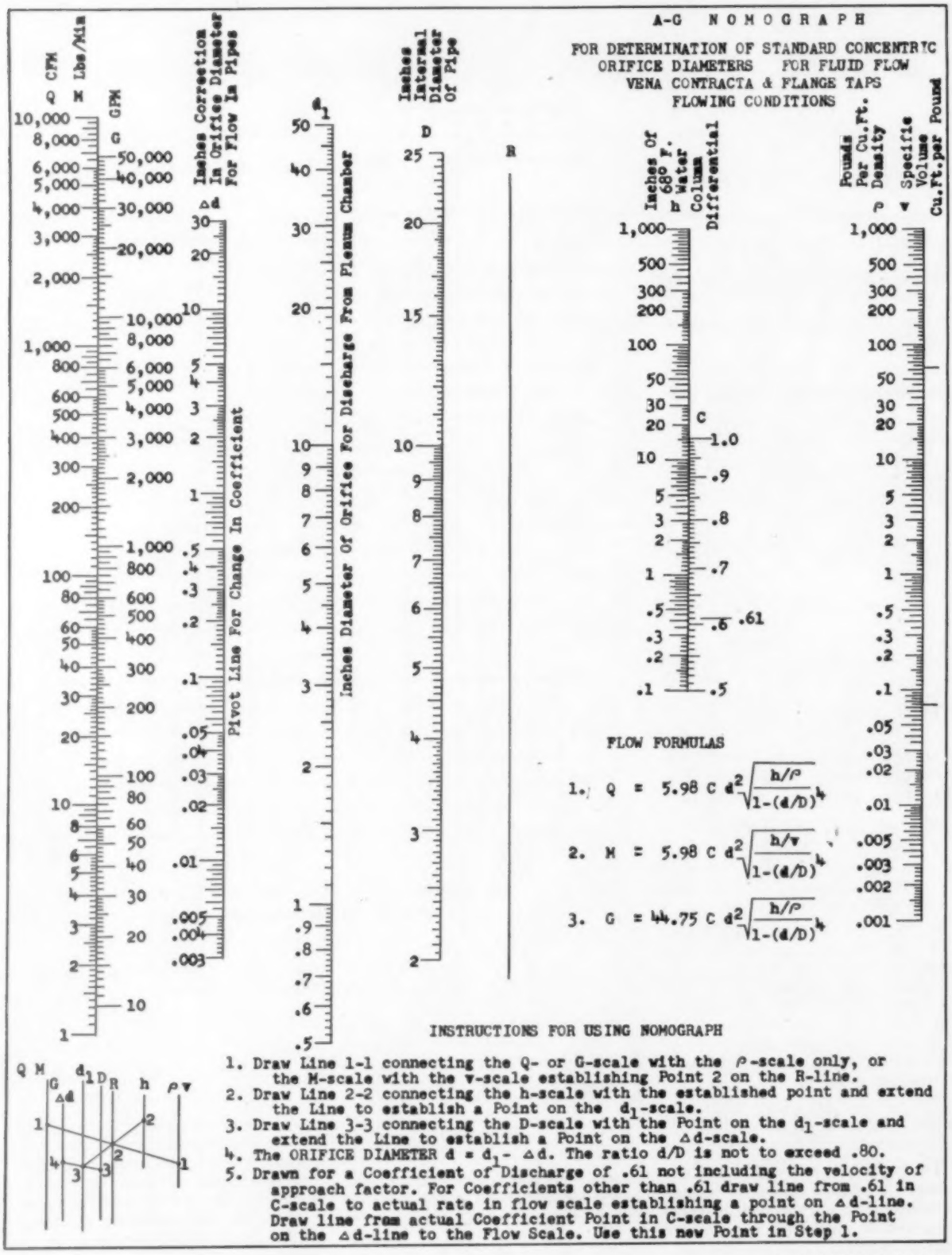

A-G NOMOGRAPH
FOR DETERMINATION OF STANDARD CONCENTRIC ORIFICE DIAMETERS FOR FLUID FLOW VENA CONTRACTA & FLANGE TAPS FLOWING CONDITIONS
Q CFM
M Lbs/Min
G GPM
Inches Correction In Orifice Diameter For Flow In Pipe
Δd
Pivot Line For Change In Coefficient
Inches Diameter Of Orifice For Discharge From Plenum Chamber
d1
Inches Internal Diameter Of Pipe
D
R
Inches Of 68° F. Water Column Differential
h
C
Pounds Per Cu.Ft. Density
ρ
Specific Volume Cu.Ft. per Pound
v
FLOW FORMULAS
1. Q = 5.98 C d² √(h/ρ / 1-(d/D)⁴)
2. M = 5.98 C d² √(h/v / 1-(d/D)⁴)
3. G = 44.75 C d² √(h/ρ / 1-(d/D)⁴)
INSTRUCTIONS FOR USING NOMOGRAPH
1. Draw Line 1-1 connecting the Q- or G-scale with the ρ-scale only, or the M-scale with the v-scale establishing Point 2 on the R-line.
2. Draw Line 2-2 connecting the h-scale with the established point and extend the Line to establish a Point on the d1-scale.
3. Draw Line 3-3 connecting the D-scale with the Point on the d1-scale and extend the Line to establish a Point on the Δd-scale.
4. The ORIFICE DIAMETER d = d1 - Δd. The ratio d/D is not to exceed .80.
5. Drawn for a Coefficient of Discharge of .61 not including the velocity of approach factor. For Coefficients other than .61 draw line from .61 in C-scale to actual rate in flow scale establishing a point on Δd-line. Draw line from actual Coefficient Point in C-scale through the Point on the Δd-line to the Flow Scale. Use this new Point in Step 1.

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Fig. 3—NOMOGRAPH for determination of standard concentric orifices.

the straight line is $y = .995 - .177x$ and therefore,

$$\left(1 + .0751 \frac{\rho Q^2}{hD^4}\right)^{-\frac{1}{4}} = .995 - .01327 \frac{\rho Q^2}{hD^4} \quad (9)$$

Substituting in Equation (5)

$$d = .5234\ Q^{\frac{1}{2}} \left(\frac{\rho}{h}\right)^{\frac{1}{4}} \left(.995 - .01327 \frac{\rho Q^2}{hD^4}\right) \quad (10)$$

$$d = .521\ Q^{\frac{1}{2}} \left(\frac{\rho}{h}\right)^{\frac{1}{4}} \left(1 - .01335 \frac{\rho Q^2}{hD^4}\right) \quad (11)$$

It will be observed that the second term of the last factor is identical to the second term in the expanded version of Equation (6), except for the value of the constant.

Equation (11) is used as the basis for the nomograph. It is first converted into the following form

$$d = .521\ Q^{\frac{1}{2}} \left(\frac{\rho}{h}\right)^{\frac{1}{4}} - \frac{.18}{D^4} \left[.521\ Q^{\frac{1}{2}} \left(\frac{\rho}{h}\right)^{\frac{1}{4}} \right]^5 \quad (12)$$

Determination of d

The first term on the right hand side of the equal sign is the value of **d** for discharge from a plenum chamber and the second term is the change in **d** for flow in pipes. The first term is designated d_1 and the second Δd. Then

$$d_1 = .521\ Q^{\frac{1}{2}} \left(\frac{\rho}{h}\right)^{\frac{1}{4}} \quad (13)$$

and

$$\Delta d = .18 \frac{d_1^5}{D^4} \quad (14)$$

Putting Equations (13) and (14) in their logrithmic forms

$$\text{Log } (d_1) = \tfrac{1}{2} \log (Q) + \tfrac{1}{4} \log (\rho) - \tfrac{1}{4} \log (h) - \log (1.919) \quad (15)$$

and

$$\text{Log } (\Delta d) = 5 \log (d_1) - 4 \log (D) - \log (5.556) \quad (16)$$

Now a nomograph (and a slide rule) can be made to determine the value of **d**. If ½ log (Q) were a scale A, ¼ log (ρ) a scale B and ¼ log (h) a scale C, then graphically $d_1 = AB/C$, and scale A + scale B − scale C represents the graphical operation on the nomograph (or slide rule). Log (1.919) is taken care of by the proper fixed relationship in position between the **Q** and d_1 scales. (A and C used in this paragraph have no relation to the same symbols elsewhere in this article.)

Having obtained d_1 it is easy to obtain Δd by subtracting the 4 log (D) scale from the 5 log (d_1) scale, again properly positioning the scales for the constant. The use of the same scale to serve for both log (d_1) and 5 log (d_1) is an important feature of the nomograph. Then

$$d = d_1 - \Delta d \quad (17)$$

The value of **d** obtained from the nomograph can be checked by solving Equation (3a) for **Q**. It is good practice to do this.

Coefficient C

In the flow equations the coefficient of discharge not including the velocity of approach factor was assumed to be 0.61, a good value when the Reynolds criterion and expansion factor can be neglected. However, should the coefficient be other than 0.61, the appropriate correction can be made on the graph. A line is drawn from point 0.61 on the **C** scale (abutting the **h** scale) to the actual rate point on the flow scale. The Δd scale line is used as the pivot line for this operation. Then draw a line from the point on the **C** scale representing the correct coefficient through the point established on the Δd scale and extend to the flow line.

This obtained new flow value represents a flow rate that is to be used to get the size of an orifice from the nomograph in the usual manner as though the new flow were the actual flow. As a matter of fact, were the nomograph drawn up for the new coefficient the actual flow point would be represented on the scale at this new location.

To state it another way: if the flow rate is measured by an orifice whose coefficient is not 0.61, the flow rate through the same orifice with equal differential pressure drop can be obtained in this manner for conditions in which the coefficient is 0.61. Since the nomograph is a 0.61 coefficient graph the diameter must be obtained by using this new point flow rate. By making corrections in hypothetical flow for the coefficients the diameters in this manner can be obtained also for other primary metering elements such as Venturis and nozzles.

Example

Find the orifice, nozzle and Venturi tube diameters when 3475 cubic feet of air of density 0.1035 pounds per cubic foot are flowing through a 12-inch internal diameter pipe and the maximum metering differential is 20 inches of water column.

Draw a line on the nomograph connecting point 3475 on the **Q** scale with point 0.1035 on the ρ scale establishing a point on the **R** pivot line. Extend a line from point 20 on the **h** scale through the established point on the **R** line to its intersection with the d_1 scale where 8.25 is read off. Extend a line from 12 in the **D** scale through 8.25 on the d_1 scale to the Δd scale where 0.34 is read. The diameter d ($= d_1 - \Delta d$) is $8.25 - .34 = 7.91$.

If the value of **C** for a flow metering nozzle is 0.96, connect 0.61 in the **C** scale with 3475 in the **Q** scale establishing a point on the Δd line. Extend a line from 0.96 on the **C** scale through the point on the Δd line to the **Q** scale, which point is now used with the other scales having the same values as above to determine d in the already prescribed manner. The value of **d** for nozzle comes out to be 6.47 inches.

If the value of **C** for a Venturi tube is 0.985, extend a line from 0.985 in the **C** scale through the point established on the Δd line to the **Q** scale. Using this new point the throat diameter **d** of a 12-inch Venturi tube should be 6.40 inches.

Scale Extensions

Orifice diameters for larger and smaller pipes than indicated on the graph can be readily obtained. The values of the **Q**, **M** and **G** scales can be increased or decreased one-hundred-fold while the Δd, **D** and d_1 scales are increased or decreased ten-fold, respectively. Scales ρ, **V** and **h** remain unchanged.

"Well, boss: you've heard that old saying about 'All work and no play'?"

Some Experiences with

Plastic Pipe for Water Services

by JOHN P. DAWSON

Mr. Dawson is Manager of the Public Utilities Commission of Dunnville, Ontario, where plastic pipe has been under test for more than six years.

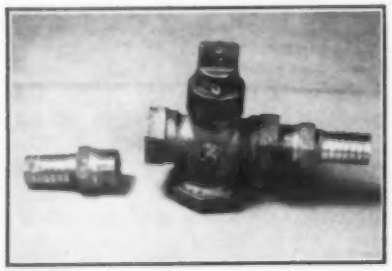
THE WATER WORKS of The town of Dunnville, Ontario has had excellent results with the use of plastic pipe for water distribution services over the past six years.

Dunnville is a small town in southern Ontario about 40 miles northwest of Buffalo and about 200 miles northeast of Detroit. The town has a population of about 5000 with 2000 water services. The system was started for the purpose of furnishing water to locomotives on the railroad line. It was turned into a municipal water supply system in 1917.

Water Character is Unstable and Temperature Varies

The water is in a constantly changing condition because the source is a badly contaminated river. As a result this water is very hard on galvanized pipes and causes severe rusting in our cast iron water mains. The soil varies from quick sand, which is quite extensive, to a hard blue clay. Part of the area was a bog and part contains an old river bed complete with shells and beach sand. We feel that we have an area that will severely test any pipe put through it, and we think we have tried them all.

The water pressure is normally 42 pounds from an elevated tank, but during times when it is required by the fire department, the pressure is raised to 95 pounds.



EXPLODED view of curb stop using two adapters.

EXPLODED view of corporation cock.

SAMPLE connection from main to house service.
Plastic pipe with adapters and stainless steel clamps

There is another variable temperature, and we seem to have a complete range there, too. Two years ago, we pumped water at 29°F and last summer the water was 93°F at the pumps.

Plastic Pipe Tested

We agreed to test plastic pipe in 1950 on a new section of pipe that was to be a temporary arrangement to serve eleven houses. The chief idea was to save money since plastic pipe was less costly than copper. We nearly gave up the idea because the house owners concerned felt we were trying to push something over on them by putting in "hoses" instead of pipe for them. Every argument in the book was thrown at us. They claimed it made the water taste funny—not to be described clearly by them, just funny. They claimed the plastic pipe cut down the pressure too much, but the meters showed very clearly that 1-1/4-in. plastic pipe will carry enough water for 11 families without serious pressure drop. It was found that the drop at the end of the line was only 6-1/2 lbs in 900 ft. at any one time, on a Monday morning.

After the first experiment, we went further in our tests. These tests included an all winter test under a crushed rock laneway where the pipe was alternately frozen and thawed while traffic continued over it. The pipe, when dry in the Spring, was found to be unharmed.

Trouble with The Clamps

There is in service now about 5-1/2 miles of various sizes from 3/4 to 2 inch plastic pipe and so far, we have had no trouble with the pipe it-

self. There have been, however, many troubles with connectors and clamps.

We started operations with connections supplied at the same time as the pipe. They were easy to use and appeared to work fine, and we used the first twenty in one area. This was all that had been supplied to start with, and so we ordered more. Luck was with us, however, because the first of the twenty broke before we received the new shipment.

During the past six years, we have had to dig up every original hard plastic fitting that we buried. They were removed because they failed in service on two points. First, there was the matter of actual breakage. This was caused by traffic hitting the water boxes, often when a house was being built, and causing the box to jar the connection and break the hard plastic fittings into the curb boxes.

A more serious trouble, however, came from a basic failure. The hard plastic fittings absorb water and swell, and the pipe does not swell to the same extent. This swelling is a slow process that only shows up after a couple of years. The writer is not sure whether it occurs during the winter or the summer, because trouble has appeared at both seasons of the year. The strain caused by this swelling is very similiar to the strain caused by the freezing, and it has actually broken stainless steel clamps and split the pipe under the clamp. The hard plastic fittings is not broken, however, and when removed shows no real evidence of freezing.

Making Our Own Connections

This utility started making its own connections after the failure of the hard plastic fitting had threatened our use of plastic pipe. Our men were so satisfied that plastic pipe was better in all respects for our water system, that they themselves invented fittings that have proven to be reliable as well as easy to make. These fittings along with an improved method of clamping seems to have removed our troubles. We now use asbestos-cement mains in conjunction with the plastic pipe, and thus we have got away from any corrosion problems.

More Troubles

It might be said that we in Dunnville might be living in a fool's paradise when we considered that the troubles with the hard plastic fittings were our only ones. In the summer of 1956 the town decided to put in a permanent street for the original 11 houses serviced with the 1-1/4 in. plastic pipe. This involved digging up this 6 year old pipe and moving it, and the payoff came when the house owners, being approached by the town to pay for a permanent new water main, only one man agreed to sign a petition for another main because they all said they were satisfied with the present service.

The pipe was re-laid after washing it off and it looked like new. It had been buried in swamp and clay and quicksand. Even the white stripe and name were clearly legible on it. One galvanized iron service pipe was in need of replacement because it looked as though it would not take another six years without trouble. The strongest recommendation for plastic pipe came when the men who had originally opposed it six years before, came to our utility to buy enough to replace their own services with the plastic pipe.

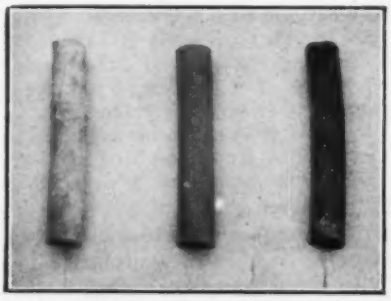
GALVANIZED Tee and plastic pipe removed after six years.
The Tee was leaking

PLASTIC pipe removed after more than five years.
Piece of pipe shown with Tee above is cut open

We have found—

1—That copper colored plastic pipe has no advantage over black except that the public are presumably fooled into believing the pipe is copper.
2—Black pipe has a higher bursting strength than grey plastic pipe when the water is hot.
3—One inch plastic pipe carries more water than 1-1/4-in. copper and 1-1/2-in. galvanized at 42 lb pressure.
4—After six years, the carrying capacity of plastic pipe is *not* lowered even with an active type of water.
5—Plastic pipe has not failed in service during the six years we have used it. We are now using Carlon pipe with a green stripe to secure an even longer life expectancy.
6—The cost in service is less than one-half the cost of copper pipe of the same physical size.
7—If the plastic pipe freezes in service during the winter, there is nothing to be done but wait for it to thaw out.

If anyone finds a way to thaw out plastic pipe we shall be happly to hear from them.



PLASTIC pipe buried 5½ years compared to new pipe.
Left—Pipe as it came from the ground; Center—pipe after washing; Right—New piece of pipe.

We have had two experiences with frozen pipe. One service was to a boat club that didn't matter, and the other was turned on before it had had enough cover over it, and it froze before being used. Neither pipe was damaged by freezing but we found no way to thaw them. The pipe is a non-conductor so it could not be heated with electricity. A hydrant thawing steam generator was tried as well as a heated wire but both these were only successful about 18 ft from our outlet so it was necessary to wait until Spring. The one service goes through old filled land, and had caused trouble before with copper pipe. It is now encased in sand, and we will know in the future whether the sand will help.

A Method of Laying Plastic Pipe

Our system of laying the pipe is fairly simple. Using a standard main tapping machine, we tap the main and insert a standard main stop for copper. The regular nut is used, and a six inch length of regular 3/4-in. copper pipe is flanged into the nut, and assembled into the main stop.

The plastic pipe is then warmed, usually in the water of the radiator of the trenching machine, and the warmed pipe is forced over the copper pipe on the main stop. Finally, a stainless steel strap is installed around the connection with a small hand banding machine called a "Bandit." This type of connection is used again at the curb stop so that everything is a standard design except for the pipe and banding material. Copper service tubing is no longer used except to make the six inch coupling.

The Dunnville Utilities believes that the plastic pipe is cheaper and more satisfactory than other materials; and in our six years of usage, we have had no cause to change our minds. It is also believed that with asbestos cement pipe and plastic pipe used in combination, we are building a more permanent distribution system for our corrosive type of water and poor soil conditions than would be obtained with the more customary materials.

To Find the Horse Power of Nearly any Drive

A Chart, Applicable to Chain Drives, V-Belts, Flat Belts, Cables, Clutches, Couplings, Etc.

Here is a handy chart for anyone who is ever confronted with one of those problems that are more or less vexing or time-consuming, pertaining to horse power of a drive. All you have to do is—lay a straightedge across the chart and there's the answer in the middle column.

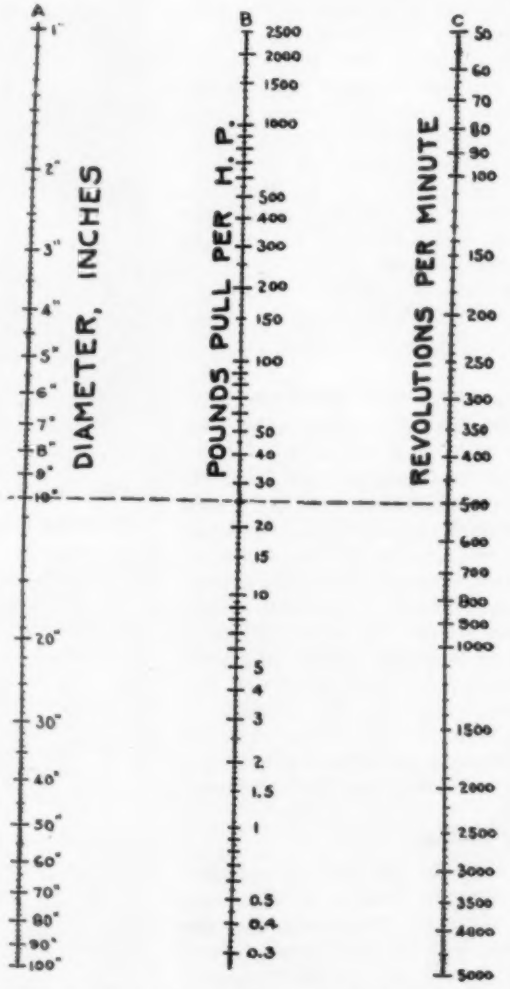
For example, let us say that you want a chain for a 10-inch sprocket which runs at 500 r.p.m., and you want it to transmit one horse power. How strong must the chain be?

The dotted line drawn across the chart shows how it is done. Connect the 10" in column "A" with the 500 in column "C" and column "B" immediately gives the answer as 25.2 pounds. If you want a chain that will transmit 10 h.p. you merely multiply the 25.2 by 10, and that gives 252 pounds as the necessary strength.

If you are designing a belt drive the chart can be used in the same way for determining the "effective pull"—which is the difference in tension between the tight and slack sides of the belt. Thus for example let us say that the above 10 h.p. drive will be a belt drive instead of a chain drive and that you will allow a pull of 100 pounds on the slack side. Since the "effective pull" must be 252 pounds it is obvious that the belt must be strong enough to resist 252 pounds plus 100 pounds, or 352 pounds.

For gear drives the "push" is found in the same way. In other words, if the diameter of the pitch circle is 10" and the gear is to make 500 r.p.m., the tooth must have a "pushing strength" of 252 pounds if it is to be a 10 h.p. drive. If it is a one h.p. drive the answer is 25.2 pounds as shown in column "B".

In other words, the chart can be applied to a very wide variety of problems involving push or pull, diameter, and r.p.m. Thus, what must be the force of the steam against the propeller blades of a steam turbine to generate a given horse power? What must be the size of a windmill in a given locality where average wind velocity is known? What horse power is required to cut a shaft in a lathe, knowing the push against the dog, the diameter of dog travel, and the rpm, of the shaft being turned in the lathe? And so on. There is no end to the number of uses to which the chart can be put.



Contributed by W. F. Schaphorst, M.E., Newark, N. J.

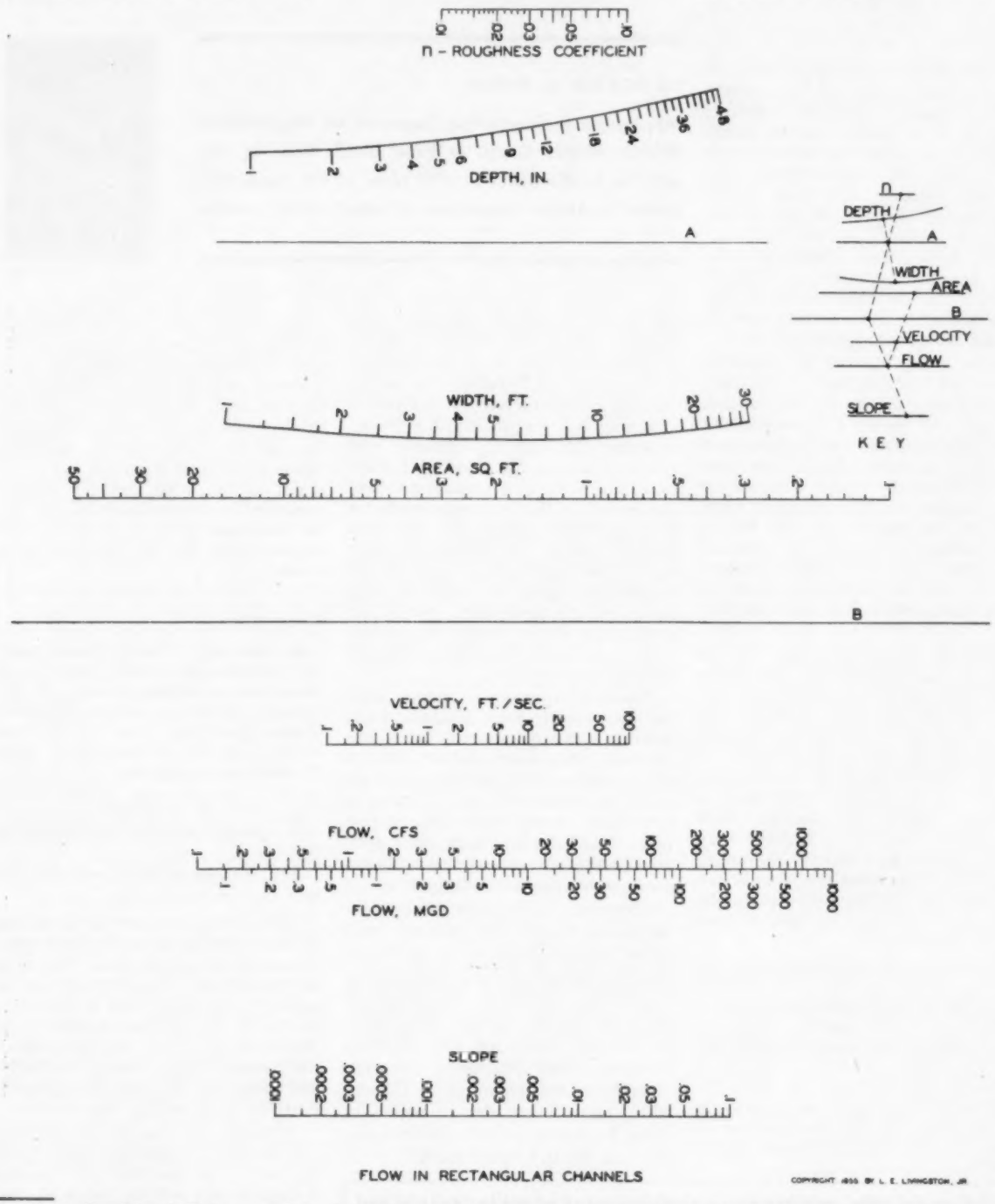
Flow in Rectangular Channels*

The accompanying chart provides a convenient solution to Manning's formula for open channel flow, as applied to rectangular channels. A complete solution is accomplished in four steps as shown in the key.

To find the flow in a given channel, a line is drawn through the "Depth" of flow and "Width" lines to pivot line A. Draw a second line through A and "Roughness" to pivot line B, and third line through B and "Slope" to "Flow." If desired, area is calculated separately, and a line drawn through "Area" and "Flow" will pass through "Velocity" at the correct figure.

by L. E. LIVINGSTON, Jr.
Dallas, Texas

To find the required channel dimensions for a given flow, proceed in the reverse order. If velocity is a controlling factor, a line through "Velocity" and "Flow" determines the area necessary. Then draw a line through "Flow" "Slope" (assumed) to pivot line B, and a line through B and "Roughness" locates a point on A. By rotating a straightedge about this point, a suitable combination of depth and width of channel is found. It may be necessary to select a different slope and repeat the calculation if the required area cannot be obtained.



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* Ed. Note: Our May 1957 issue carried essentially this same nomograph which now proves to be erroneous. One of our readers, Irving Goldfien, C.E., research engineer for the city of Milwaukee, Wisc., in checking found errors in the nomograph. These have been corrected by Mr. Livingston in the above draft which has been re-checked by Mr. Goldfien. Readers will please mark the May 1957 nomograph "Erroneous".

Some Operational Problems Of the Small Water Works

In which a little knowledge can be a dangerous thing.

by FOSTER S. BURBA

Mr. Burba is Operating Engineer of the General Water Works Corp. in Pine Bluff, Ark. In this article, he discusses briefly some of the important points in better operation of small water works.

IN VIEW of the demands made on it, a water system will have certain problems peculiar only to a utility; therefore, it is difficult for the public in general to understand these problems. Also, the water system has problems common with those industries engaged in processing or transporting a product. In view of the extremely low charges made for the large quantities of water furnished as well as the service rendered, the water works is doing a commendable although often unappreciated job.

There are a number of plant operators who are doing a very good job, and they are to be commended. By many of these, a knowledge of plant operation was obtained the hard way and involved considerable time and effort on their part. The one or two operators in a small plant have basically the same task (or rather, seek the same end result) as obtained in a large plant by a staff of supervised technicians. And operators of small plants have done an excellent job.

Although those responsible for the operation of the plant are sometimes hindered by factors beyond their control (for example poor planning and engineering, unreliable equipment, etc.), one of the main problems in the small water works is that of personnel. A community may have a desirable source, an adequate plant and system; yet these facilities may be invalidated by improper operation. This type of personnel problem is due to a number of factors, such as job insecurity, low salaries, lack of employee benefits, etc.

An important consideration in improving plant operation is emphasizing to the public, to the administrative authorities, and to the operator, the importance of the water system and the consequences of poor plant operation. There are many operators who receive little or no preparation in assuming their duties. Too often, the only indoctrination received before assuming full responsibility is to accompany the retiring operator (or pumper) around the plant for a short time. The essence of a training course conducted in this manner usually is to keep things going and the tank full. Of course, the retiring operator may not be qualified (or may be uncooperative) and the beginner may learn certain procedures which are undesirable and probably will not receive a full understanding of his job and its responsibility.

Those who come in contact with the operators in their plants and observe operations can cite many undesirable procedures due to personnel training as outlined. One example is the operator who was starting a centrifugal pump with the suction valve closed and discharge valve open because that was the procedure of his predecessor (as he remembered it).

Sometimes, a little knowledge is a dangerous thing. One operator read about copper as being a good coagulant. Because he was not getting a good floc with alum, he decided to purchase copper sulfate and try it for awhile. These, as well as other instances, show that being conscientious is not enough in itself. The operator must know the principles of water treatment and be able to apply them to his individual plant.

A valuable step in improving operations would be to minimize turnover of personnel by improving both financial and political conditions. A training and educational program would assist in developing operators. An aid to being better operators would be to receive on the job training and by some means become grounded in the fundamentals of water treatment prior to assuming full responsibility for the operation of a plant.

Coagulation

In operating a conventional plant, the operator can usually feed enough coagulant to obtain a water of acceptable appearance in the clearwell. Certain problems may result from having only this as a standard, three of which are as follows:

1. Waste of chemicals.
2. Residual alum in the distribution system.
3. Corrosion of the distribution system.

All chemicals added can be utilized to the fullest by applying the correct amount in the proper place. This must be determined for each plant, may be aided by jar tests, and is best controlled by physical and chemical tests. As the quality of the raw water varies, the chemical dosage usually is affected and sometimes the point of application must be changed for best results.

Although the results of jar tests can seldom be duplicated in the plant, the effect of varying the chemical dosage usually will be indicated, thus providing a means of minimizing experimentation on a full-plant scale. Chemical and physical tests are essen-

Ed. Note: This paper presented before the Southwest Sect. AWWA, has been released for publication in Water & Sewage Works.

"A community may have a desirable source of water supply and an adequate plant and system, yet these facilities may be invalidated by improper operation."

tial for efficient plant operation and this information should be recorded for future reference. A number of plants have chemical feeders which will not properly feed at the desired rate. This is due to either the machines being of the improper size or incapable of discharging chemical consistently under adverse weather conditions.

In alum coagulation, there is a narrow pH range in which the solubility of aluminum hydroxide is a minimum (and the precipitation of floc a maximum). At a pH outside this range alum can pass through a filter and precipitate in the distribution system, with a resultant clogging and decrease in capacity of mains and services. Each piece of pipe or fitting removed from the system should be inspected for possible sludge accumulation. Residual alum can easily occur in the treatment of a soft water where optimum results of alum coagulation are obtained at a pH below 7.0 but stabilization by alkaline addition requires a pH above 7.0. It is possible that split feeding of lime or other chemical will be required for corrosion control. Regular checks for aluminum content correlated with pH control during coagulation and sedimentation will prevent this precipitation.

System Corrosion

Where chemicals are added merely for coagulation, it is likely that a corrosive water will be discharged to the system. This will cause tuberculation of cast-iron and galvanized mains. This, too, will result in a decrease in the life and flow capacity of mains and services, and possibly discolored water at the consumer's tap.

For either the corrosion or residual alum problem, chemical tests will be required for control of chemical dosage. The split feeding of alkaline material to the filtered water, or use of hexametaphosphates or other material may be required if alum is to be used as a coagulant. As an alternative, a coagulant other than alum might be used.

The operator who is continually striving to do a better job of operating, who realizes the effect that treatment or lack of proper treatment may have on the distribution system, and who uses chemical and physical tests as a means of controlling the addition of chemicals, should avoid the above three general results of poor operation in a conventional plant.

Bacteriological Purity

A fundamental requirement of a water plant is that it deliver a potable water which is safe for drinking purposes. In too many plants the only assurance that a safe water is being delivered comes from submitting four or five samples of water per month to a bacteriological laboratory. Within a week or two from date of sampling, a letter might be forthcoming which states: "The above results show the water to be free from coliform organisms and, therefore, safe for drinking purposes at the time of sampling."

Bacteriological analysis is important and necessary, however favorable reports can be assured by daily controlling and testing the purification processes in a properly working filter plant which has adequate chlorination. Maintaining a chlorine residual after sufficient contact time (where such treatment has previously been confirmed by bacteriological analyses) is the best means available of being assured of a safe water. The problem of the operator's relying only on infrequent bacteriological laboratory reports for a safe water, is due to misunderstanding by him.

"A valuable step in improving operations is to minimize turnover of personnel by improving both financial and political conditions."

Iron Removal

In the operation of iron removal plants, of which there are a number in Arkansas, the problems vary, depending on the type of treatment utilized. Since many of the iron-bearing water supplies are soft, many iron removal plants are comparatively simple. Some consist of aeration and filtration only. Thorough preliminary work preparatory to design is required to be sure that the proper treatment method is incorporated for the particular supply. Occasionally, a plant must be revamped before it will operate satisfactorily.

The iron-bearing water is usually corrosive and care must be exercised in selecting the proper materials of construction and equipment to assure reliability and satisfactory life of equipment. One important consideration in the design of an iron removal plant is that it be capable of aerating and producing a satisfactory water when subjected to varying rates of flow.

Plant Problems

A number of small plants in use today were designed with a large safety factor and built in the 1920's or 1930's. Increased demands on these facilities have presented several problems, as follows:

1. Baffled flow for mixing and coagulation is not satisfactory for variations in flow. Installation of variable-speed mechanical flocculators has improved coagulation in a number of plants.
2. A single-compartment sedimentation basin constitutes a problem in cleaning during the summer months when consumption is high. Also, little time is permitted for repair or maintenance of structures and equipment.
3. To a lesser degree, single-compartment clearwells present the same problems.
4. Baffling in sedimentation basins is inadequate or unsatisfactory.
5. Design of overflow weirs received little consideration.

With regard to filtering equipment, a number of plants have inoperative rate-of-flow controllers and loss-of-head gages. In certain installations the equipment is unsatisfactory from the beginning and is soon abandoned. In other instances abandonment may be due to lack of the operator's understanding the working principle of the equipment, even though it is operating or has operated satisfactorily.

Equipment representatives or consultants may sometimes be reluctant to re-work a piece of inoperative equipment even though it can be satisfactorily restored at a reasonable cost. Instead, they may recommend that it be replaced by a more complicated unit. At times, those in charge are reluctant to spend money for maintenance or repair of equipment if they can get by without it. Consequently, the equipment may be abandoned for this reason.

Leaking valves and valve stems are undesirable and due primarily to lack of initiative by the operator.

Operating Problems

Too many operators do not backwash or operate a filter in a manner which has been proven satisfactory. A check of sand expansion, probing of bed during backwashing, and other procedures are desirable to determine the condition of the filter and the effectiveness of the backwashing.

"One item often overlooked in plant operation is safety.—Accidents don't just happen; they are caused—usually by carelessness or lack of knowledge."

In view of rising labor costs and unavailability of good operating personnel, many small plants are being converted from manual to either automatic or semi-automatic operation, which requires a minimum of personnel. Usually, a compartively simple system can be designed which will require a minimum of equipment and controls. Alarms, shut-off controls, and alternate units are required for reliability of operation.

The installation of protective equipment, such as lightning arrestors, a third overload relay on magnetic starters, cutouts in event of improper prime of pumps, etc., will minimize damage to equipment. In automatic operation, one important consideration is the priming of centrifugal pumps. An alternative to priming devices or foot valves is the installation of vertical shaft turbine pumps, which present no difficulty in priming and which will not be subjected to flooding.

The difficulty of not knowing what is happening to pumping and other equipment while no one is on duty is relieved by use of recording charts on various lines and equipment. Pressure recorders on raw water and treated water transmission mains, hour meters on electric motors for total length of operation, master meters, and water level indicators at strategic reservoirs will give a very good record of the operations.

One consideration is economy in pumping. By testing each pumping unit, maintaining equipment, and replacing inefficient units with efficient ones, a saving in power costs will be realized.

An item often overlooked in plant operation is safety. Accidents don't just happen, they are caused-usually by carelessness or lack of knowledge.

Although not necessarily an operating problem, the appearance of the plant and plant grounds can be greatly improved so as to be appealing to both visitors and operators.

New Water Supply Proposed for Pennsylvania Communities

A multi-million dollar plan to bring pure mountain spring water to four Western Pennsylvania Counties has been proposed by John Ware, chairman of the Board of The American Water Works Company. The plan is to bring pure soft water from the mountains to many communities in Allegheny, Westmoreland, Washington and Fayette Counties. This plan will involve construction of a 134 billion-gallon reservoir in the mountains southeast of Pittsburgh and a gravity-flow underground aqueduct that will carry the water across four counties.

The project would replace the chemically-treated hard water from the polluted rivers with pure mountain stream water.

Currently engineers are working on a feasibility report that will answer the crucial question, "How much will it cost?" Primary cost of reservoirs, tunnels and pipelines to bring the water to the communities is estimated in the neighborhood of 250 million dollars to be financed by bonds issued by Westmoreland Water Authority.

Source of Supply

A huge dam and a series of valleys will form the reservoir on Indian Creek in Fayette and Westmoreland Counties and the reservoir will be fed by the Indian and Laurel Hill Creeks, with a future additional supply of water available by diversion of the Casselman River. A sparsely settled watershed area of 207 square miles will feed the reservoir.

The reservoir will have a water level of 1,450 feet elevation above sea level for the 134 billion-gallon capacity and a 1,460 feet elevation for a 151 billion-gallon capacity if needed.

Completion of the project will require four years.

A concrete-lined, underground aqueduct 11.4 feet in diameter and approximately 42 miles long will be constructed at an average depth of 800 feet below the surface to transport the pure water. The aqueduct from the reservoir to Laurel Hill Creek will add 7.3 miles and the aqueduct to the Casselman River would add another four miles. The aqueduct would have a daily capacity of 650 million gallons, more than enough to supply the 1960 four-county requirement of 262 mgd.

The Municipal Management Company and American Water Works Company, under Mr. Ware's direction, have had the proposal under study for some time and have concluded that the plan will be able to supply the area for many generations to come.

Model of proposed $250 million reservoir and aqueduct system to bring fresh mountain water to four Western Pennsylvania Counties.

Looking at model are L. J. Reinicker, vice chairman, John Ware, board chairman and J. J. Barr, president of the American Water Works Company.

Things You Can Not Do!

"You can not keep out of trouble by spending more than you earn. And, you can not establish sound security on borrowed money."—*Abraham Lincoln*

New Smyrna Beach's Water Tower

Spherical shape a pleasing park feature

by HENRY C. SUTER
Technical Writer
Daytona Beach, Florida

MORE STORED water and water of a softer quality is now available to the people of New Smyrna Beach, Fla. because of a completed water-improvement program.

The storage is supplied by a 100,000-gallon Watersphere erected by the Birmingham office of the Chicago Bridge and Iron Company. Located in Old Fort Park, the water-storage tank is an attractive park feature at the same time.

High and low water-levels in the tank are controlled by an altitude valve that connects electrically with a pumping station. The pumps stop when the water level is approximately 2½ feet from the top, and start when it drops about 25 feet. At the high level, the pressure at the foot of the riser pipe is over 60 pounds per square inch.

Since New Smyrna Beach, like most Florida cities, draws its water from wells, the water is sufficiently hard to require softening. The softening plant that the city uses is based on the zeolite process.

The softening plant was erected by the Permutit Company. It discharges softened water to a 500,000-gallon reinforced concrete water reservoir for storage; the water is pumped to the distribution system as needed.

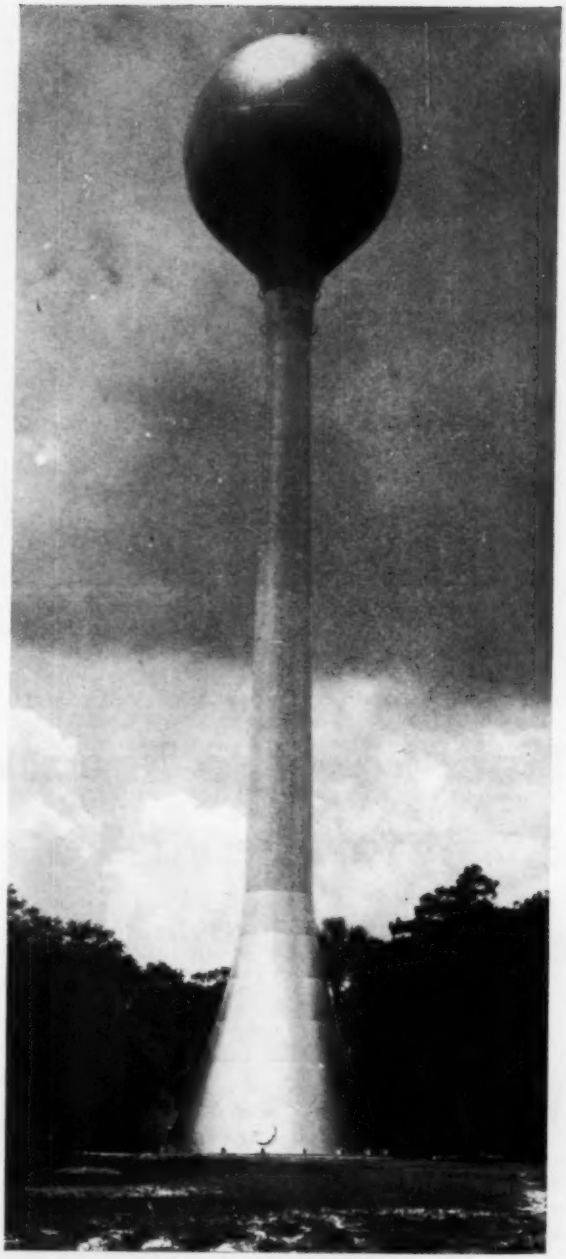
The new system increases the capacity of the system from 1 mgd (million gallons daily) to double this figure. It also increases the pressure from 40 to 60 psi.

Because of the increase in pressure, and also because of the replacement of a 6-inch main by an 8-inch main, the city was able to dispense with a booster pump near the North Bridge that serves adjoining Coronado Beach. Now all that is needed is an altitude valve at the Coronado Beach elevated tank to control the supply.

Plans and specifications for the improvement were prepared by Russell & Axon, consulting engineers, of Daytona Beach, Fla. The project was constructed during the administration of Mayor C. B. Jones; John C. Ferris is city manager of New Smyrna Beach.

Because of Florida's recent rapid growth in both population and industry, water-supply problems have been created in many of its communities. While the State has bountiful storehouses of water of generally good quality, the water contains some salt that may in time cause trouble.

With a high point of only around 32 feet above sea level, Florida must put its water reservoirs in the sky to get gravity distribution to consumers. The watersphere (30 feet in diameter) is perched on a hollow steel column which varies in diameter from 30 to 6 feet. Inside the supporting column are a ladder and a 10-inch riser pipe. Its crown is 147 feet above the earth, an unusual height in that region and one that makes the structure's pleasing lines visible from afar.



Reservoir in the Sky

MAIN control building houses everything except screens, pumping station, settling units and digesters.

New Sewage Treatment Plant At Petersburg, Va.

Solves Appomattox River pollution problem of long standing

by T. T. MUSGROVE, Jr.

Mr. Musgrove is Superintendent of Treatment and Sewerage Systems in the City of Petersburg, Va. He here describes in general the necessity for the new plant and the processes included.

WHEN the city of Petersburg, Va., placed its new $125,000 sewage treatment plant in operation in November 1956, the event marked the end of an era of stream pollution which had existed since 1733. In the spring of 1957, Atlantic shad and herring came up the harbor and river channel without encountering Petersburg's raw sewage for the first time since Peter Jones opened an Indian trading post at the foot of the falls on the Appomattox River in colonial days.

Geographically, Petersburg is situated at the head of navigation on the Appomattox River, nine miles southwest of its confluence with the James River, a section of the Old Dominion rich in the tradition and history of the state and nation. The origin of the city may be traced to several early Indian trading posts that became a settlement at this point on

the Appomattox River as early as 1646.

The first town was actually laid out by William Byrd in 1733, and first chartered in 1748. It was chartered as a city in 1850; its present charter was granted by the General Assembly in 1875. Petersburg has a population of approximately 45,000. Known as the "Cockade City", it has much historical background dating from both the Revolutionary and Civil Wars.

Petersburg is the agricultural center of Southside Virginia, and has also developed into a diversified manufacturing center of considerable importance. The varied manufactures range from the processing of cotton, tobacco and peanuts, which are grown nearby, to the manufacture of world renowned optical lenses, hardware, luggage, mechanical pencils and fountain pens, iron products, furniture, plastics, packing crates, wines, garments, and numerous miscellaneous products.

MOTOR ROOM at main pumping station houses one 25-hp and three 30-hp Fairbanks Morse Motors.

Station is kept so scrupulously clean that even professional photographer had difficulty in filtering out "shine". Color scheme includes fire engine red for motor cages, white for supports and shafts, brilliant red for floors, and warm cream tile walls.

Added Problems

Camp Lee, known to thousands of troops in World War I, became Fort Lee after its reconstruction in World War II. It is now the Army's Quartermaster Training Center and is located on the outskirts of the city. The city supplies water to this installation, but not sewage disposal.

The Central State Hospital is also located just outside the city limits and discharges its sewage into the city facilities. This is a mental institution having patients and staff numbering approximately 4,000.

Petersburg is proud of its history, but has its eyes focused on future progress. Transportation, land, water, natural gas, electricity, and labor are present in abundance for industry to expand in a mild climate.

Many problems were encountered as regards the physical layout of the various buildings and functions of the sewage treatment plant. The river bank is very rugged, and is crowded with railroads, canals, buildings, rock outcrops, and a hydroelectric plant. Initially, under this program the Appomattox River interceptor line was constructed parallel and adjacent to the river. The various outfall sewers were connected to this line, which in turn discharges sewage into the main pumping station at the head of the harbor.

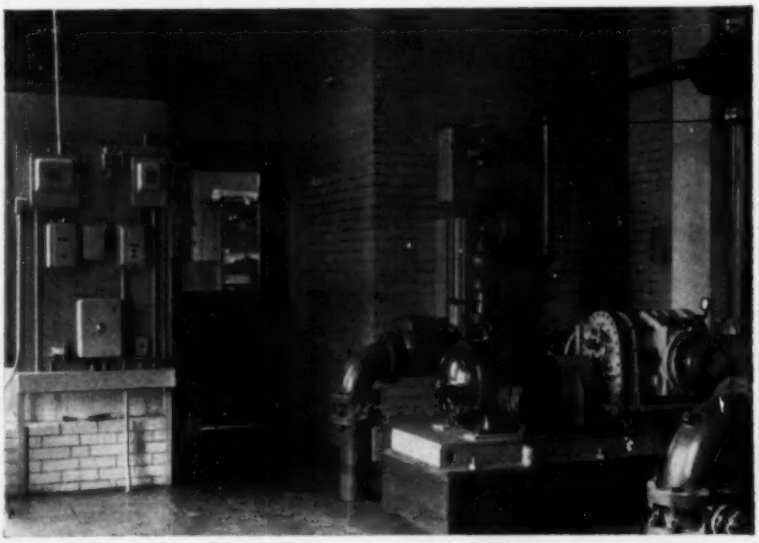
Screening and Pumping Station

Upon reaching the station all sewage passes through a 4-inch bar rack equipped with a mechanical trash rake. The sewage is then passed through a highly selective 3/4 inch opening automatic bar screen equipped with a moving chain rake. Screenings are brought up to the main floor level and deposited on an enclosed platform for examination, after which they are fed into a hammer mill for shredding and grinding before being re-introduced into the raw sewage.

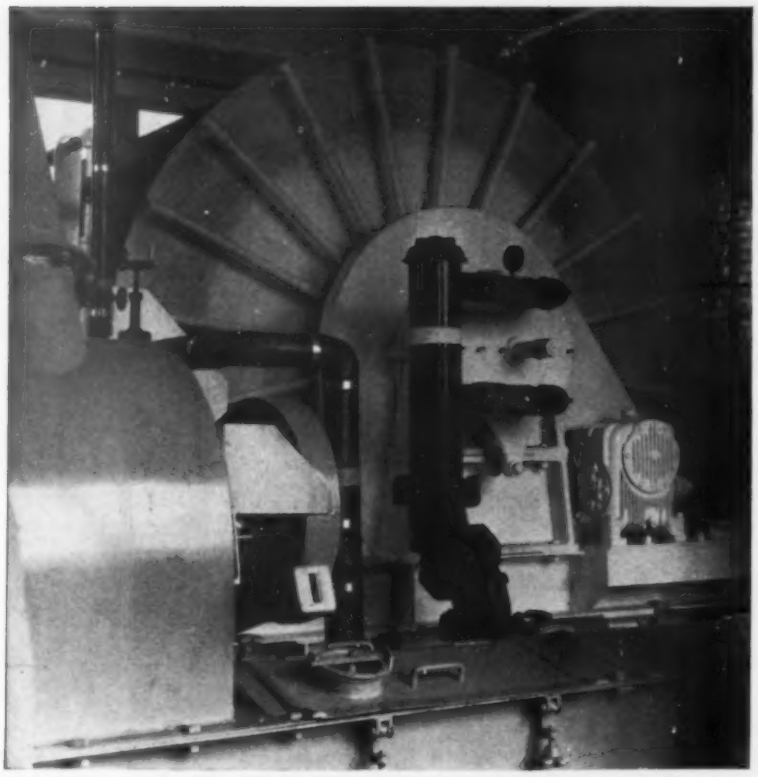
After passing through this double screening action the sewage progresses through a Parshall meter flume and into the wet well. Four automatically controlled vertical electric-driven pumps capable of handling 12 mgd pump the sewage through a 30-inch cast-iron main approximately 3/4 mile to the treatment plant.

Primary Settling

Just prior to reaching the influent splitting box at the plant, pre-chlorination is provided. The splitting box divides the influent equally and passes the sewage into an aerated basin in



BLOWER by Chicago Pump Co. is energized by 25-hp Westinghouse motor to produce more than 700,000 cu ft of air per day. Fitzgibbons boiler (left) uses sludge gas for domestic heat.



PUG MILL mixes damp sludge cake and dried product before introduction into Raymond C-E flash dryer. Coil filter by Komline-Sanderson is kept spotless by operators, although painted gloss white.

which grit is precipitated. Grit is conveyed in a suspended state by an air lift to a grit dewatering bed. The sewage flow then progresses through twin parallel pre-areation tanks, where it undergoes turbulent rolling action activated by a series of air diffuser tubes for a minimum period of 30 minutes.

Following pre-areation, the sewage flows into two primary rectangular settling tanks having an average detention period of 2½ hours. All settleable solids are then conveyed to hoppers by mechanical flight collectors, which also automatically skim and collect the scum into tilting weir trough for discharge into the scum well.

Sludge Digestion

The raw sludge is drawn into a sludge well through telescoping valves, after which it is transferred to the primary digester by plunger-type sludge pumps along with scum. Lime may be introduced in the sludge well if required for pH control.

The settled sewage from the primary settling tanks escapes over skimming weirs into the primary effluent channel, where a second chlorine application is made. Following this chlorination the mixture spills over another set of weirs into the chlorine contact tank, which is equipped with sludge collectors and has an additional average detention period of 1 hour. This chlorine contact tank may be converted later to a primary settling basin. The treated sewage then leaves the tank through ports into the final effluent channel, containing a Parshall meter flume. From the meter the treated sewage discharges through a cascade into tidal water of the Appomattox River.

Two digesters are employed; each is 65 feet in diameter. The primary digester is equipped with a floating cover, and the secondary digester with a moving gas holder cover. The primary is heated by an external heat exchanger using sludge gas as fuel.

The secondary digester is equipped with a supernatant selector and is designed as a holding and thickening tank for the digested sludge. The digester building, situated between the digesters, is divided into two rooms. One-half of the building at grade level houses the heat exchanger; the other half is given over to gas metering and control devices. All pumps covered with digester operation are located on the basement level of the digester building.

The digested sludge is transferred, by remotely controlled pumps, from the secondary digester into a conditioning vat located on the second floor level of the main control building. The conditioning tank is also under remote control for ferric chloride dosing from vats on the third floor, and from lime slurry vats located on a fourth floor level of the Control Building.

Sludge Drying

After dewatering on a 150—square foot vacuum coil filter, the sludge cake travels by conveyor belt to a pug mill mixer, where previously dried pulverized sludge is integrated with the damp cake. The mixture is then fed into a cage mill flash drying system operating at a temperature in excess of 1,000° F. The dryer consists of a mixture trough, cage mill, furnace, cyclones, and conveyors to dry and pulverize the sludge to not more than 10 percent moisture. The dried sludge is now ready for storage from where it can be dispensed in bulk loading or bagged by automatic apparatus. The final product is sold and used as an excellent soil conditioner.

The plant site is situated on a narrow strip of land between the river and the harbor and is attractively landscaped and fenced. The sewer system machine shops building is located to the rear of the digester and utilizes waste sludge gas as a heating fuel.

Chlorination and Operator Facilities

The ground floor of the main control building is equipped with a room in which there are two large chlorinators, vacuum feed controls, and an electric liquid chlorine evaporator. Another room houses ton-size chlorine cylinders, scales, and connecting tubing. An electric hoist is employed to lift the ton container to connecting position.

An adequately equipped laboratory is manned by a graduate chemist and a laboratory technician. Locker rooms and showers are tiled and the office and laboratory are air conditioned. An operators' room provides space for logging and report desks, as well as a lunch room.

The plant is now in complete operation and functioning properly in every department. It is of considerable interest and economy to the plant operation to find that the sludge cake is produced at an average moisture content of 61 percent.

The industrial wastes from local plants and manufacturers have not posed too great a problem to date; however, for six days of the week sewage ranges in color from pink to a brilliant red from certain of these wastes. Tobacco leaves and feathers are also ever abundant.

Costs

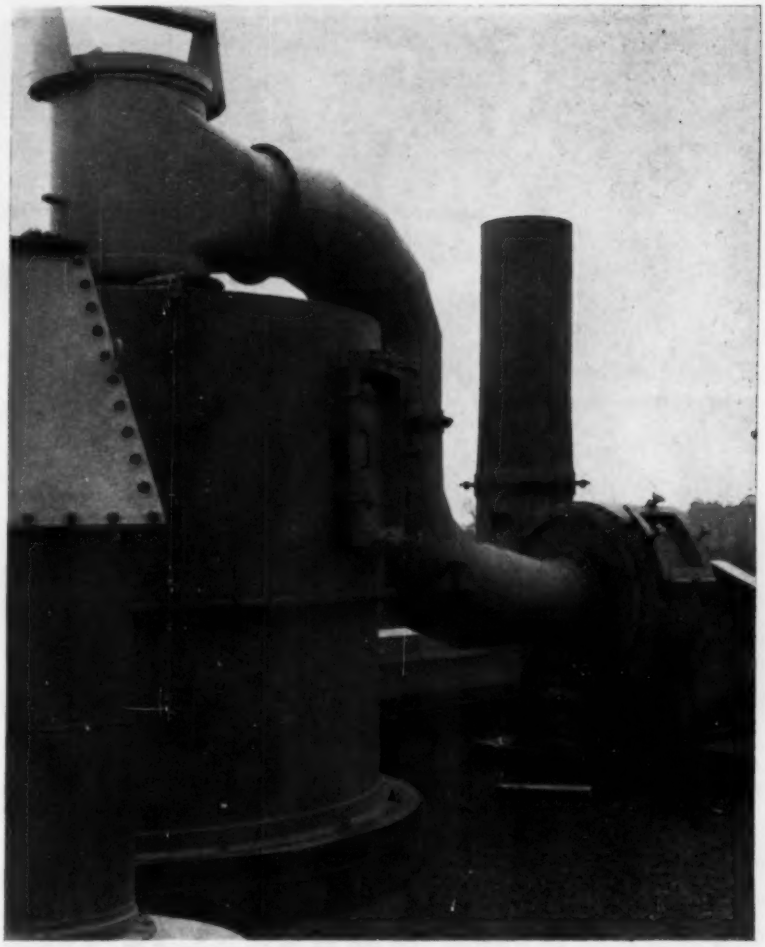
Sewage treatment plant, pumping station, and force main	$855,631.11
Appomattox River interceptor	299,885.55
Trunk sewers	82,803.28
Sludge drying equipment	73,000.00
Total	$ 1,311,319.94

Builders and Suppliers

The plant was designed for a population of 55,000 and a 7-mgd flow. Design and engineering were by Wiley & Wilson, Consulting Engineers of Lynchburg, Va. The contractor was English Construction Company, Altavista, Va.

Principal equipment, and the suppliers, as well as other contracts, were as follows:

Appomattox River interceptor,
Van Doren Brothers.
Flash dryer,
Combustion Engineering, Inc.
Vacuum coil filter equipment,
Komline-Sanderson.
Settling tank sludge collectors,
Link-Belt Co.
Pre-aeration equipment,
Chicago Pump Co.
Chlorination equipment,
Wallace & Tiernan Co.
Digester equip. & heat exchangers,
Pacific Flush Tank Co.
Raw sewage pumps,
Fairbanks-Morse Co.
Screens and grinders,
Link-Belt Co. and Greundler Grinder
Trash rack and rake—
Montague-Betts Co.
Trunk sewers,
English Construction Co.



FLASH DRYING equipment is located on third-story roof of main control building.

The Square Water Pipe of 1733*

Engineers are familiar with old time square built sewers but few are aware that square water pipes were used in 1733 in a new water supply for the city of Belfast, Ireland. The promoter of this scheme was one William Johnston of New Forge, near Belfast, and it was he who introduced the square water pipe.

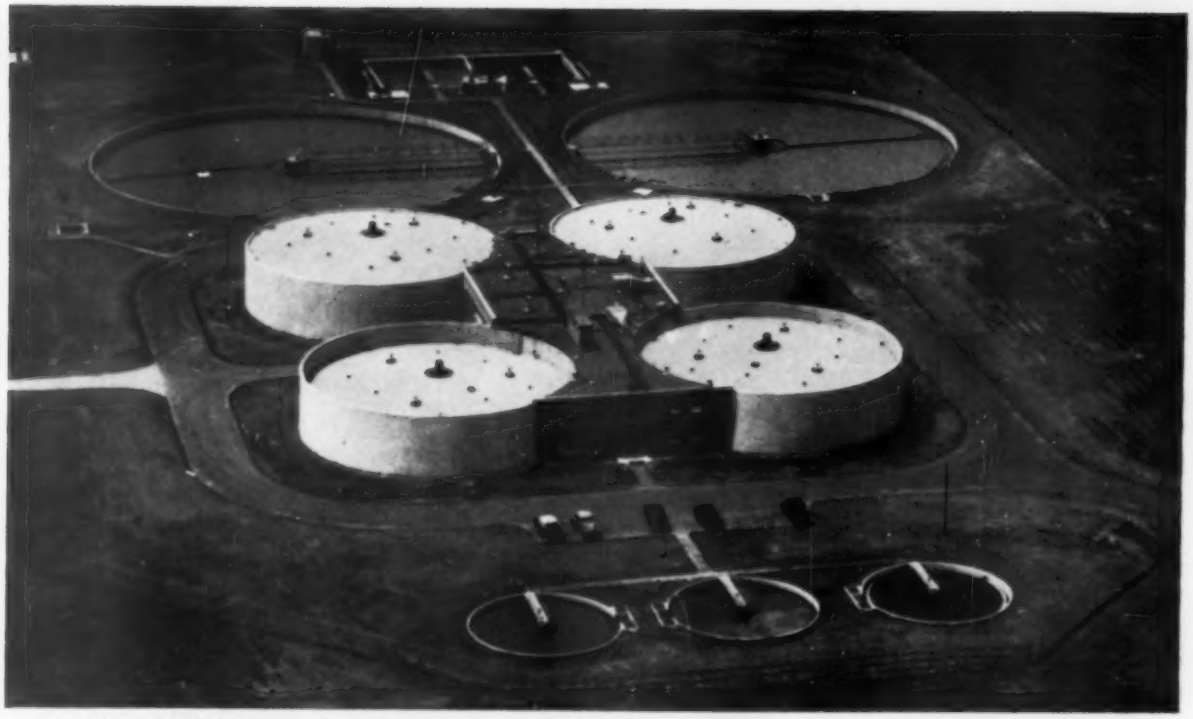
In those days pipes for water supply were made of bored out tree trunks but Johnston felt that better piping could be made out of sawn scantlings of elm, oak and larch. Johnston's box-pipe was made from 12 inch by 2 inch planking cut and formed into shape by nailing and making the joints by stepping the planks. The wooden walls thus built were continuous and the piping was laid in a trench and encased with lime mortar and small stones rammed all round the pipe to support it and preserve it from exterior decay. Stop valves for the mains were also made of hardwood, oak being employed. The valve consisted of a wood cube bored out to carry the water through it and down-bored on a taper to take the tapered stopper. The stopper, also made of oak, had a water slot which opened as the cock was turned.

The piping and valves were durable and stood up to the test of use and time, for one of these box-pipe mains was still in service in 1789, and in a good state of preservation. The water preserved the inside, and the lime mortar encasing the outside, after a half century or more. The designer of the square water pipe, nicknamed "Pipe-water" Johnston by the way, was indeed a practical water engineer and his box-pipe while not ideal when considering the mechanics of hydraulic-flow, was truly an innovation and quite servicable in that slow early Georgian age.

*Contributed by Colin Johnston Robb, Ballynahinch, County Down, Ireland.

Things You Can Not Do!

"You can not strengthen the weak by weakening the strong. Nor, can you further the brotherhood of man by encouraging class hatred."—*Abraham Lincoln*



FLOATING COVER digesters at Wilmington, Del. make up an integral part of a compact treatment plant.

Mesophilic Anaerobic Digestion

Part I—Fundamental Factors of the Process

by L. L. LANGFORD

Mr. Langford is Eastern Sales Manager of the Pacific Flush Tank Co. In this installment of a two part article he reviews a number of basic considerations with reference to the process of sludge digestion as carried on in sewage and waste treatment plants.

AS INDUSTRIES expand and new ones develop, as production is pushed ever and ever higher, and as centers of population continue to grow in size, a mounting burden of liquid wastes is placed on our sewage treatment plants, on rivers, streams, lakes and coastal waters.

The necessity for a large part of the treatment which sewage and industrial wastes should receive before their final disposition stems from putrescible organic matter and bacteria which it contains. One method of treating these putrescible wastes is by mesophilic anaerobic digestion, a biological, biochemical process which requires close coordination between the designer of the equipment and operator of the plant.

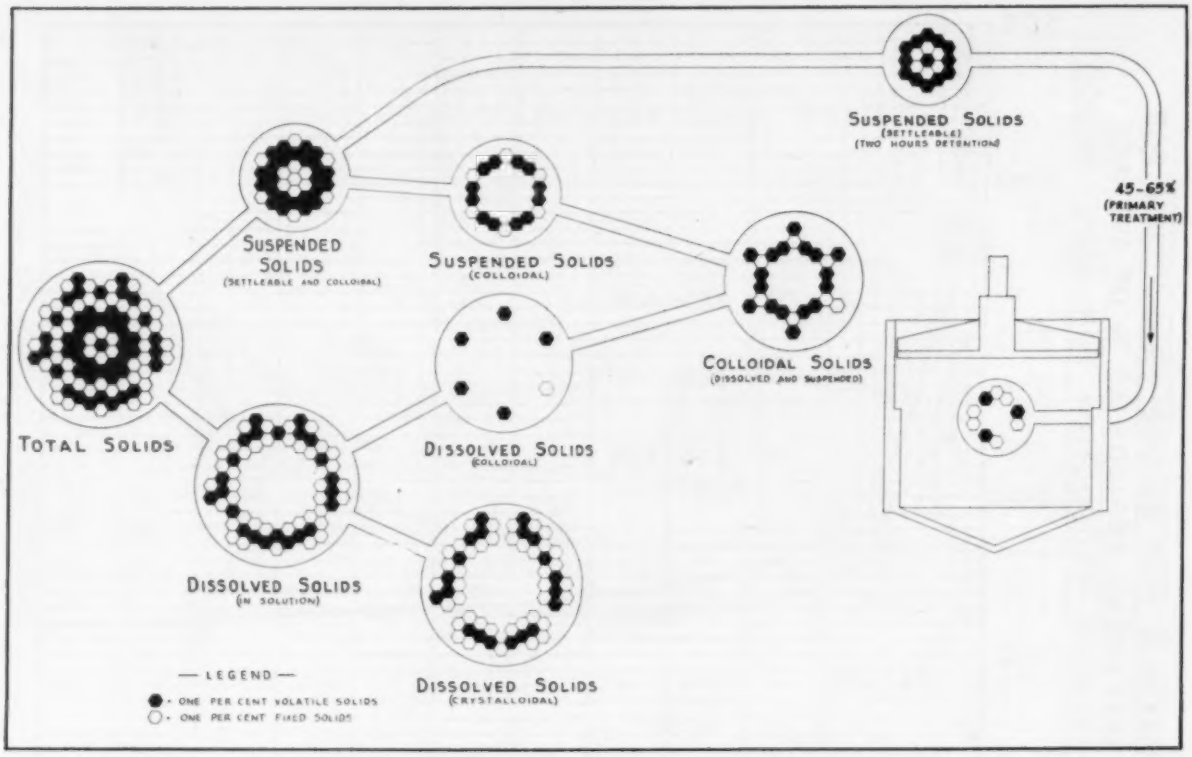
A full understanding of the importance of the relationship between design, construction, operation and maintenance is necessary to enhance the efficiency and economy of organic wastes treatment. Pertinent to this understanding is a knowledge of the fundamentals of the process as well as the design, equipment and operation of the process.

History of Sludge Digestion

A dividing line in the history of

Ed. Note: This paper, presented at the Manhattan College Conference on Anaerobic Sludge Digestion in New York City in 1957, is published here by permission of the college.

Part 2 of the paper is devoted to structural, mechanical, and operational considerations.



THE PROPORTION of sewage solids which reach a digester is shown by graphical representation of the physical conditions of the principal constituents of medium strength sewage.

sludge digestion undoubtedly dates back to 1925 and the advent of the Downes floating cover. That era witnessed the first general use of heating of separate sludge digestion tanks, by means of internal hot water coils, and the attempted utilization of sludge gas in gasoline and marine engines for power.

Ten years earlier, C. C. Hommon, in Atlanta, Ga., had utilized gas collected from Imhoff tanks for heating, cooking and street lighting, within the plant area. Prior to that, tanks of the Hampton, Travis and other types, as well as Cameron septic tanks, were used for solids separation and such reduction as the latitude of the installation permitted. Mechanically equipped, fixed roof tanks accompanied the trend toward separate sludge digestion, with the objective of breaking up top material and removing the heavy bottom sludge.

The advantages of series operation became apparent during this period resulting in improved quality supernatant, causing less harm to the then increasingly popular activated sludge process for complete treatment works. The desirability of insulating against heat losses accompanied the more widespread understanding of the importance of temperature as a factor in the metabolism of the reducing organisms.

The necessity of attempting to maintain constant and positive gas pressure became evident, as more municipalities utilized sludge gas for heat and power. The insulated floating cover was recognized as meeting these requirements and, simultaneously, affording a large degree of scum submergence.

Today, we have the benefits of continued research and field experience, which has confirmed the value of adequate mixing of concentrated material, within a narrow range of optimum temperature, throughout the entire active area of a primary digester.

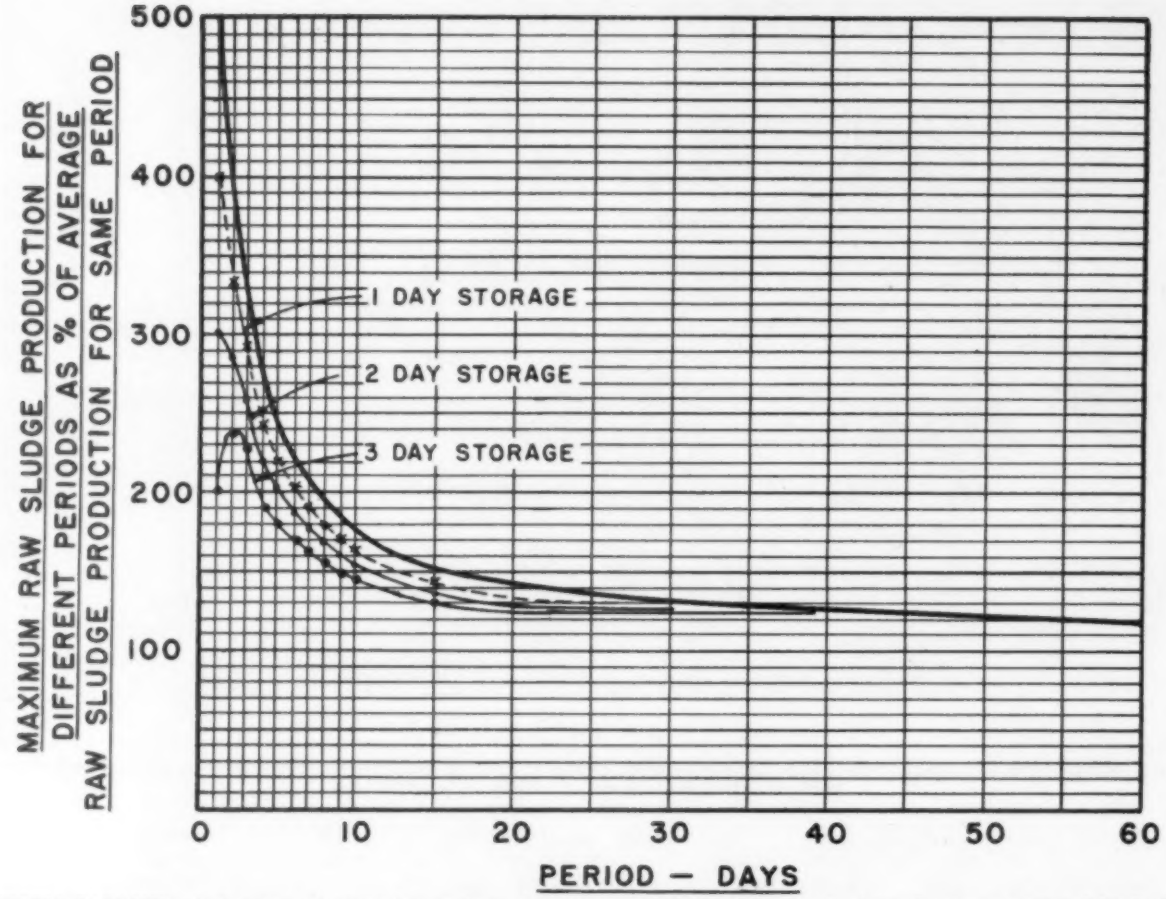
Limited mixing is a natural result of active digestion, by virtue of rising gas particles. If, for extraneous reasons, natural mixing is inadequate, it is now recognized that supplemental multiple-point gas recirculation will

TABLE I

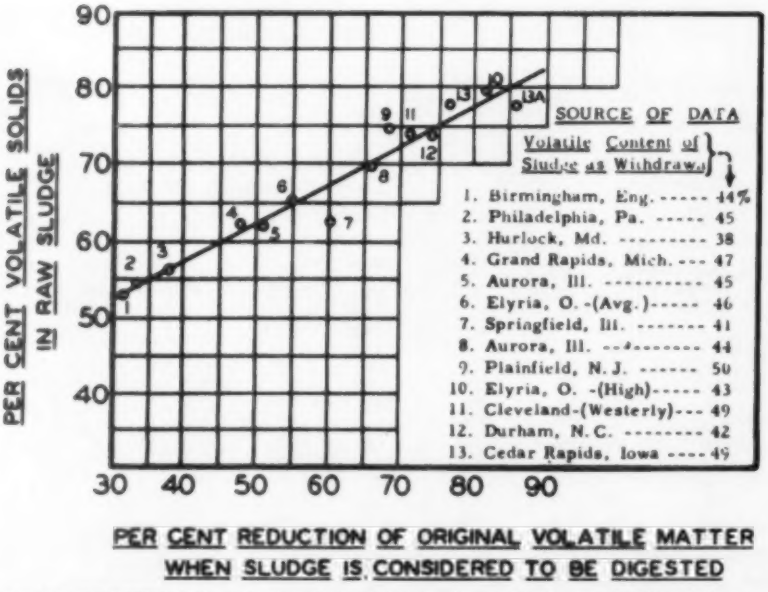
Quantity of Sludge Produced by Primary Sedimentation from 1.0 mil gal of Raw Sewage Containing 100 ppm of Settleable Solids *

% Removal Settleable Solids	% Dry Solids in Sludge					Lb. of Dry Solids in Thickened Sludge
	4%	5%	6%	7%	8%	
	Gallons of Thickened Sludge					
50	1250	1000	834	715	625	425
55	1375	1100	917	787	687	467
60	1500	1200	1000	860	750	510
65	1625	1300	1082	932	812	552
70	1750	1400	1165	1000	875	595
75	1875	1500	1247	1072	937	637
80	2000	1600	1330	1142	1000	680
85	2125	1700	1412	1214	1062	722
90	2250	1800	1500	1285	1125	765
95	2375	1900	1582	1357	1187	807
100	2500	2000	1668	1430	1250	850

* Weight of raw sewage mixture taken @ 8.5# per gallon.



EXCESS CAPACITY of digesters required for maximum conditions of sludge production is shown by curve prepared by R. A. Allton from data collected in 1932 at Chicago, Cleveland, Columbus, Syracuse, Rochester and elsewhere.



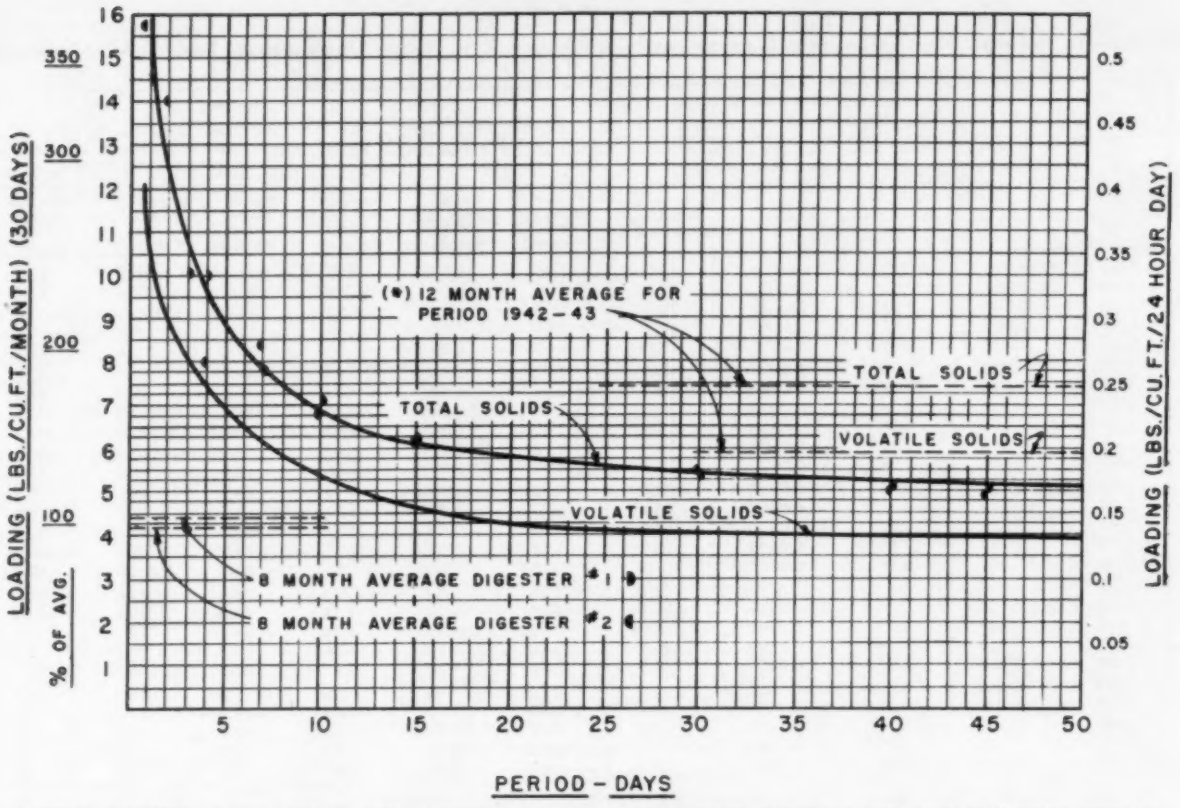
WHAT CONSTITUTES well digested sludge is shown by curve developed from data at 13 cities, in which per cent reduction of volatile matter, by digestion, is related to volatile matter in the raw sludge solids. (After Schlenz).

tend to increase the efficiency of digestion, through the elimination of thermal and gravitational stratification, above the point of desired concentration of well digested material.

Toward the accomplishment of making better use of digester capacity (or reducing digester capacity requirements), the use of increased solids concentration of raw input has remained a cogent reason for using care in drawing settled material from sedimentation tanks, as well as for the use of plain or mechanically equipped concentration units.

As both the mechanical and thermal limitations of internal hot water coils became evident during World War II, the first practical external sludge heaters became commercially available shortly thereafter. The use of these external sludge heaters, operating on either gas or oil, automatically and safely, contributed to bringing about more general acceptance of the practice of inoculation of raw sludge with hot seeded material.

Along with the means of adequate heating, sufficient mixing and the maintenance of an optimum tempera-



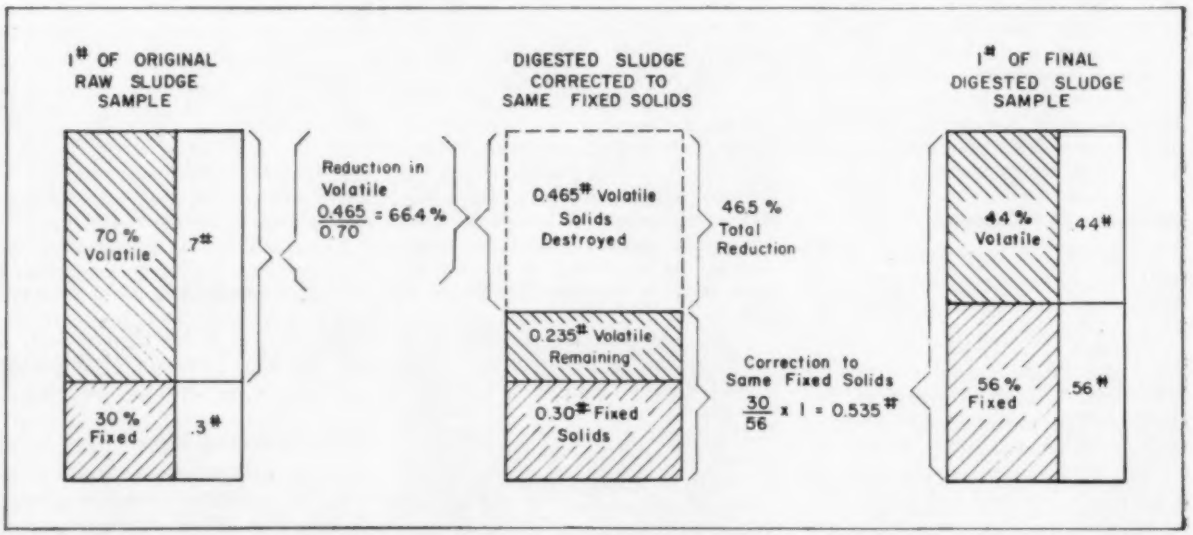
ACTUAL LOADING of raw sludge solids, expressed as pounds (dry weight), added per cubic foot of digester capacity for any period, based on data collected at Cedar Rapids, Iowa from Feb. to Sept. 1936. (After Schlenz)

Note the 12-month average for 1942-43, when the maximum 1-day loading was 1.14 lb. total solids and 0.9 lb volatile solids per cu ft.

ture within a narrow range, became twin considerations.

As recently pointed out by Davis[1] digestion has certain values other than the stabilization of sludge. These values may, under certain conditions, be of economic importance. Digestion of volatile wastes reduces solids content and the volume of the solids to be handled and, due to a reduction of putresible matter, is capable of producing a more acceptable material for final disposal. Digestion allows for smaller dewatering and drying facilities and permits flexibility in plant operation, not otherwise available.

While it is true that incineration of liquid sludge, with the elimination of the expensive vacuum filtration process, offers a field for further development, and that the concentration of liquid primary sludge by the flotation process, prior to incineration, has been incorporated in one of the larg-


1# OF ORIGINAL RAW SLUDGE SAMPLE
DIGESTED SLUDGE CORRECTED TO SAME FIXED SOLIDS
1# OF FINAL DIGESTED SLUDGE SAMPLE
70 % Volatile
.7#
30 % Fixed
.3#
Reduction in Volatile 0.465 / 0.70 = 66.4 %
0.465# Volatile Solids Destroyed
46.5 % Total Reduction
0.235# Volatile Remaining
0.30# Fixed Solids
Correction to Same Fixed Solids 30/56 x 1 = 0.535#
44 % Volatile
.44#
56 % Fixed
.56#

HOW TO CALCULATE per cent reduction in volatile solids is gr aphically shown using data from Aurora, Ill. (After Schlenz).

TABLE 2

Relationship Between Digester Loading, Capacity per Capita, and Raw Sludge Displacement Time* (After Schlenz)

RAW SOLIDS LOADING (Pounds)					DIGESTER CAPACITY PROVIDED IN CUBIC FEET PER CAPITA (Basis of 0.20 Lb. Total Suspended Solids in Raw Sewage Per Capita.)			DISPLACEMENT TIME IN DAYS (Basis of Raw Sludge Added at the Indicated Moisture)		
TOTAL DRY SOLIDS		VOLATILE DRY SOLIDS (Assumed as 70% Volatile)								
Per Cu. Ft. Per 30 Day Period	Per Cu. Ft. Per Day	Per Cu. Ft. Per 30 Day Period	Per Cu. Ft. Per Day	Cu. Ft. Per Lb. of Volatile Added Per Day	Primary Settling @ 60% Removal	Trickling Filter @ 90% Removal	Activated Sludge @ 95% Removal	Primary Settling 95% Moisture	Trickling Filter 96% Moisture	Activated Sludge 97% Moisture
0.30	0.010	0.210	0.0070	143.0	12.00	18.00	19.00	312.5	250.0	187.5
0.45	0.015	0.315	0.0105	95.2	8.00	12.00	12.70	208.2	166.6	125.0
0.60	0.020	0.420	0.0140	71.4	6.00	9.00	9.50	156.3	125.0	93.8
0.75	0.025	0.525	0.0175	57.2	4.80	7.20	7.60	125.0	99.9	75.0
0.90	0.030	0.630	0.0210	47.6	4.00	6.00	6.30	104.1	83.3	62.5
1.05	0.035	0.735	0.0245	40.8	3.43	5.14	5.43	89.3	71.3	53.6
1.20	0.040	0.840	0.0280	35.7	3.00	4.50	4.75	78.1	62.5	46.9
1.35	0.045	0.945	0.0315	31.7	2.67	4.00	4.22	69.5	55.6	41.7
1.50	0.050	1.050	0.0350	28.6	2.40	3.60	3.80	62.5	50.0	37.5
1.65	0.055	1.155	0.0385	25.9	2.18	3.27	3.45	56.8	45.4	34.1
1.80	0.060	1.260	0.0420	23.8	2.00	3.00	3.16	52.1	41.6	31.3
1.95	0.065	1.365	0.0455	22.0	1.85	2.77	2.91	48.2	38.5	28.8
2.10	0.070	1.470	0.0490	20.4	1.71	2.57	2.71	44.7	35.7	26.8
2.40	0.080	1.680	0.0560	17.8	1.50	2.25	2.37	39.1	31.3	23.4
2.70	0.090	1.890	0.0630	15.9	1.33	2.00	2.11	34.7	27.8	20.8
3.00	0.100	2.100	0.0700	14.3	1.20	1.80	1.90	31.3	25.0	18.8
3.30	0.110	2.310	0.0770	13.0	1.09	1.64	1.73	28.4	22.8	17.5
3.60	0.120	2.520	0.0840	11.9	1.00	1.50	1.58	26.0	20.8	15.6
3.90	0.130	2.730	0.0910	11.0	0.92	1.38	1.46	24.0	19.2	14.4
4.20	0.140	2.940	0.0980	10.2	0.86	1.29	1.36	22.3	17.9	13.4
4.50	0.150	3.150	0.1050	9.5	0.80	1.20	1.27	20.8	16.7	12.5
4.80	0.160	3.360	0.1120	9.0	0.75	1.13	1.19	19.5	15.6	11.7
5.10	0.170	3.570	0.1190	8.4	0.70	1.06	1.12	18.4	14.7	11.0
5.40	0.180	3.780	0.1260	7.9	0.67	1.00	1.05	17.4	13.9	10.4
5.70	0.190	3.990	0.1330	7.5	0.63	0.95	1.00	16.5	13.2	9.9
6.00	0.200	4.200	0.1400	7.2	0.60	0.90	0.95	15.6	12.5	9.4

* The cross hatched bars indicate the ranges recommended by the "Tentative Standards for Sewage Works" of the Upper Mississippi River Board and the Great Lakes Board of Public Health Engineers, covering ten states.

est plants in the East, digestion is still considered a very necessary conditioning step in the majority of smaller organic wastes treatment plants.

Where it is necessary to produce an odor-free final product, digestion continues to hold its own as an economical conditioning method. By reducing the amount of solids to be further processed and, thereby, the expense of chemicals, the cost of digestion can generally be economically justified. The storage space available by the digestion process represents an additional operation advantage. In addition, the plant can generally be operated with less laboratory control and less skilled personnel.

Mechanisms of Digestion

Digestion has been defined as the reduction of volume of waste organic substances resulting in partial gassification, liquefaction, stabilization, destruction of colloidal structure, release of moisture and mineralization.[2] The term "controlled digestion" has assumed a proprietary usage denoting the use, in whole or part, of floating covers, PFT-Pearth gas recirculation, supernatant selectors and gauges, external sludge heating and safe gas collection, use or wasting by burning. The mechanism of anaerobic sludge digestion as carried on in the mesophilic range of 65 to 100 deg. F. is described in the following paragraphs.

Following acid fermentation (accentuated by the presence of any appreciable quantity of carbohydrates), there is stage of acid regression, followed by alkaline fermentation and, lastly, a humification stage of decreasing gasification and increasing pH. As the organic acids formed in the first stage are neutralized by the products of the following stages, activities reach an equilibrium.

In actual practice, all stages of digestion are present simultaneously—particularly in a primary tank. Proper balance can best be maintained by the frequent addition of fresh raw solids, thoroughly mixed with well buffered (digested) material, and by withdrawal, so regulated as to always leave some of the riper sludge available as "buffer".

Anaerobic digestion is affected by toxins as well as by stimulants.[3] The rate of digestion is influenced by such environmental factors as reaction (pH), temperature, the proximity of proper organisms to the organic matter to be reduced, as well as by the chemical composition of the solids.[4] While, in general, raw sludge is composed largely of carbohydrates, the extent of its decomposition will depend, not only on the nature of the organisms present, but also on the nature and amount of nitrogen, as pointed out by Waksman.[5]

The bacteriological aspects of digestion, being fundamental, should dictate structural, mechanical and operational considerations, although this is not always recognized by the student, designer, equipment manufacturer, or operator. Structural, mechanical and operational considerations will be discussed in Part II of this article.

Establishment of a suitable bacteria flora, naturally or artificially, constitutes the first step of the process. Maintenance of adequate numbers of active autotrophic and heterotrophic saprophytes is the next essential.

The problem of digestion, therefore, resolves itself into ascertaining and maintaining an environment which will favor and stimulate the activities of desirable bacteria and, at the same time, eliminate or arrest the activities of all undersirable forms[6].

Factors Affecting Digestion

In actual operations, there is always the possibility of receiving toxic or otherwise interfering trade wastes. While the source of toxic materials

can usually be traced and their discharge controlled, control of abnormal quantities, or shock loadings, of oils, fats, grease, hair or feathers, for example, is not always possible.

In primary digestion units, the reaction (pH) of the raw waste may be well below that considered desirable, necessitating addition of chemicals or the retention of a larger quantity of buffering sludge.

Maintenance of optimum temperature is sometimes difficult to achieve. This may result from inadequate means, indifference or ignorance of conditions, due to inadequate instrumentation.

Pumping or piping limitations can reduce efficiency of the process to a serious degree, through lack of means for withdrawal or transfer of sludge liquor or other digester material, quickly and easily. Inadequate or interrupted digested sludge handling facilities can also be a factor.

More particularly, lack of inoculation of raw sludge with seeded material and inadequate mixing of the digesting mass can prove costly, because this condition may lead to the formation of a cold, oily, hairy, seedy looking blanket which reduces active tank capacity, blocks off passage of gas and potentially menaces digester piping. Due to the fact that temperature establishes the intensity of sludge activity, even in a mechanically mixed digester, a temperature range of between 97° and 99°F in a primary digester is required, if the oils, fats and waxes are to be reduced.

Accelerated Digestion

Increased digestion efficiency was the result of mechanical means of mixing in active digesters. Adequate mixing results in more continuous presentation of food to greater numbers of active organisms. Supplemental mixing above the bottom zone of concentrating digested solids, eliminates thermal and solids stratification within the active volume.

Because of the fact that it is now possible to do a better job in less time, we must remember that we are still confronted with field limitations, as yet uncontrolled. Power-outages, equipment breakdowns, interruption of digested sludge disposal and personnel problems, resulting from sickness, accident or vacation schedules, represent but a few of these limitations.

High Rate Digestion Vs. Accelerated Digestion

Radical thinking in terms of reduced digestion capacity is often coupled with consideration of reduced degree, as well as reduced time, of digestion. Such thinking can become dangerous, despite the emphasis on raw material concentration.

High rate filters is a term denoting a process of limited oxidation. High rate digestion may unavoidably follow this path, resulting in limited reduction.

While high rate digestion processes may appear to have an economic advantage in decreasing capitalized investment, an extremely important point, that is often overlooked by the municipality or authority, is that the processes require trained supervision of operation.

Accelerated digestion, however, encompasses supplemental mixing of frequently fed, concentrated and inoculated raw sludge within the mass of active digesting material, together with the maintenance of optimum temperature—all without disturbance of the concentrating, digested sludge in the lower reaches.

Gas Production

Gas production varies with temperature, ranging from about 7 cubic feet per pound of volatile solids added, at 50°F., requiring about 60 days, to about 12 cubic feet per pound of volatile solids added, at 90°F., requiring only about 15 days.

Depending upon conditions of digestion, sludge gas will contain:

Carbon Dioxide	(CO_2)	from about 25 to 35%
Hydrogen	(H_2)	from about 1.0 to 5%
Methane	(CH_4)	from about 50 to 68%
Nitrogen	(N_2)	from about 2.0 to 7%
Oxygen	(O_2)	from a trace to 0.1%

together with traces of as many as fifteen additional chemical constituents.

The inoculation of raw sludge with sludge liquor, from the active, alkaline fermentation stage of a digester, will materially reduce the time required to establish maximum gas production. As pointed out by Grune, "The maximum gas production indicated for a well seeded mixture may actually never be obtained with an unseeded sludge." In addition, " . . . the presence of seed provides a buffer against the overproduction of volatile acids and the establishment of acid fermentation."

Data and Diagrams

In the accompanying tables and diagrams there appears basic data of importance to the understanding of the fundamentals of mesophilic anaerobic digestion of sewage sludge. Table 1, for example, shows the relation of sludge volume to dry solids content; Table 2 shows the relation of raw solids loadings to required sludge digester capacity and displacement time. The diagrams and their importance to the fundamentals of sludge digestion are explained in the captions accompanying the figures.

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Mexico Has a Nation-Wide Water Works Program

A nationwide program to supply drinking water for approximately 3 million residents now lacking such facilities has been launched by the Department of Hydraulic Resources of Mexico.

Total cost is estimated at approximately 200 million pesos ($16 million), of which 75 per cent will be provided by the government. The rest will come from private interests.

Some 50 large and medium waterworks are under construction along with 143 classified as "small" in centers of lesser population and 189 classified as "minimum" which consist of providing basic piping without immediate house-to-house service.

The program was made possible under a law passed at the last session of the Mexican Congress, giving the federal government authority to collaborate with municipalities in establishing public utilities of this kind. The law authorizes the Hydraulic Resources Ministry to invest up to one-half of the cost of such works in communities of less than 30,000 population, and up to one-third of the cost for works in communities with population exceeding that figure.

Methods of Handling Dried or Incinerated Sewage Solids

by ROBERT K. HAMPTON, P. E.
Manager New York Office
Beaumont Birch Company

THE DISPOSAL of solids removed from sewage presents an increasingly difficult problem to cities of all sizes due to high land values and increasing labor costs. Drying of sewage sludge of beds requires area, not only for the beds but also for ultimate disposal of the dried sludge. Drying of sludge in furnaces for use as a fertilizer or soil conditioner offers another method of disposal. Incinerating the sludge to a sterile ash offers still another method of disposal which requires less area for ultimate disposal.

Drying of filtered sludge solids for soil conditioner or fertilizer presupposes that there is a market which can be developed economically. Incinerating the sludge results in less solid matter to handle. In either of these cases, handling or conveying of the burned sludge ash or dried sludge is an item too often given scant attention in overall plant design. Proper study of the conveying problem in the initial stages of plant design can result in sizeable economies both in capital investment and operating costs.

Methods of Handling Solids

If solids are dried or incinerated, they are first dewatered, then handled in drying or incinerating furnaces. In either case the solids may be handled in several ways. Figure 1 shows a flow diagram of the various methods of handling and disposing of sewage solids, either fresh or digested.

Incineration or Drying

When solids are incinerated and a lagoon or fill area is available, hydraulic pumping of the ash is simple, adaptable and trouble-free. Hydraulic systems can handle most types of ash regardless of temperature; small clinkers or stones; it can convey the ash to a final disposal point without intermediate handling.

When land conditions prevent the use of lagoons, storage bins are used to store the ash dry. The stored ash in the bin may be hauled away periodically, usually by truck, to a convenient fill area. Mechanical conveyors, such as screw conveyors for horizontal conveying and bucket elevators for vertical lifting, are commonly used to convey dry ashes from underneath the furnace to the storage bin. Pneumatic conveyors have also been used in certain instances to convey ashes from under the furnace to the bin.

When drying is utilized either by itself or in conjunction with burning, the type of conveying equipment is dictated mainly by the type of furnace selected. For the flash drying type of furnace, pneumatic conveying is used not only to convey, but as an integral part of the process. For multiple hearth furnaces the dried sludge is usually conveyed mechanically by means of screw conveyors and bucket elevators.

Hydraulic Ash Handling

The component parts of a hydraulic ash handling system, as shown in Fig. 2, are a steel ash hopper or concrete sump for receiving the ash discharged from the furnace and for storing it for a short time, a centrifugal pump with electric motor, discharge pipeline to lagoon, electric controls either manual or automatic and water supply for agitation and make-up.

The ash hopper is usually made of steel plate preferably conical in shape and equipped with sizing grid, access doors, agitator nozzles, float controlled make-up valves, drain, overflow and pump suction pipes. A steel hopper is shown in Fig. 3. Concrete sumps have the same appurtenances as steel hoppers but are arranged to suit sump design. The size of hopper is determined by the amount of ash storage desired (usually a minimum of one hour) and the minimum water level required for proper pump suction. Too often hopper design has been dictated by furnace heights, set before considering the ash handling system requirements.

Ash Pumping

The ash pump is usually a centrifugal type with a fully shrouded impeller with the passages opened to handle solids, etc. The impeller is

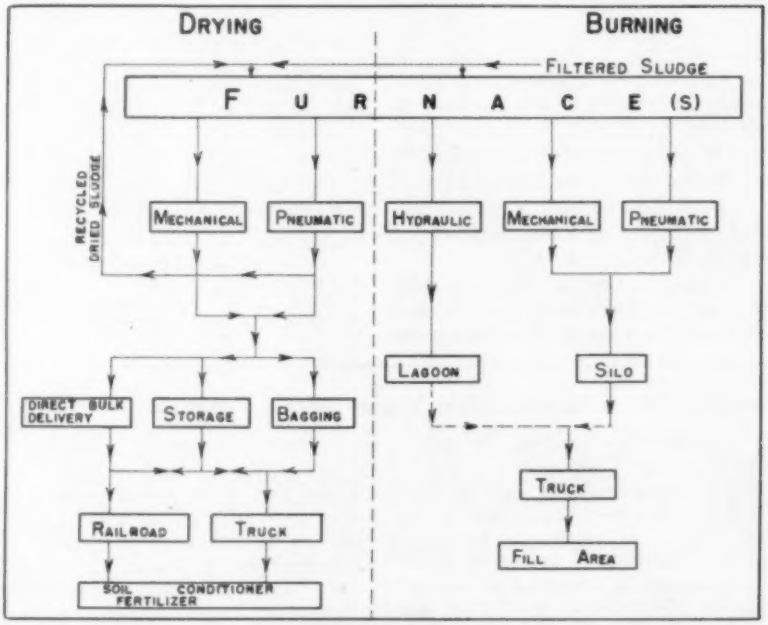


Fig. 1—FLOW DIAGRAM for handling dried or burned sewage sludge solids.

normally made of abrasion resisting metal, such as "Ni-Hard." High pressure water is used to keep grit out of the stuffing box and to reduce wear at the suction seal. The pump size depends mainly on pipe size. The pump motor horsepower generally varies from 15 hp using a 3-inch pipe line up to 500 feet long to 50 hp or more using a 6-inch pipe line 2000 feet long. The actual pipe line contour together with the number of elbows and segregating valves and difference in elevation between the discharge end of the pipe line and free water level in the ash sump will, of course, determine the actual horsepower.

Pipe size varies both with pipe line length and capacity desired. For small plants with one or two furnaces 3 inch diameter up to 500 feet and 4 inch diameter up to 2000 feet in length are normally used. With large furnaces or three or more medium size furnaces, 4-inch pipe for the short lines and 5-inch or 6-inch pipe depending on capacity required are used on long pipe lines. Eight inch lines are infrequently used and only when very high capacities are required or pipe lines losses due to many bends indicate more economical horsepower requirements.

Water requirements vary with pipe size, capacity requirements and pipe line configuration. The amount varies from 150 gpm in short 3-inch lines to 900 gpm in long high capacity 6-inch lines. High pressure agitator and pump seal water depends on the size of the hopper usually about 120 gpm at 50 to 60 psi for each hopper and pump. Due to the amount of water required, filtered effluent water from the final settling tank is often used for a large proportion of the water requirements. Strainers and the consequent manual cleaning of the strainers is the only added operational problem. City water is still desirable for pump seals and agitator nozzles.

Photo courtesy Nichols Engineering

Fig. 3—MULTIPLE hydraulic storage hoppers under Nichols Herreshoff furnaces.

Hydraulic System Operation

Operation of hydraulic systems may be manual or automatic. On manual operation the operator starts the ash pump motor and then opens vertical ash pit doors on some types of furnaces. On other types of furnaces where ashes discharge directly into a hopper the operator merely starts the pump motor on a predetermined cycle. It is best to control agitator nozzles and pump seal water automatically by means of solenoid valves rather than depend on the operator to open manual water valves.

On automatic systems the pump motors, agitator nozzles and pump seal water are automatically turned on by a time clock or float control system and stopped after a predetermined time. The normal water level is maintained by independent float controlled valves. If effluent water is used it is better to use pilot operated valves on the make-up lines. When several furnace hoppers empty into a common discharge line special segregating valves are required. A common collecting hopper may be used to eliminate the maintenance and operating problems encountered with material occasionally clogging segregating valves. The common hopper also allows two or more hoppers to discharge simultaneonsly through a common pipe line.

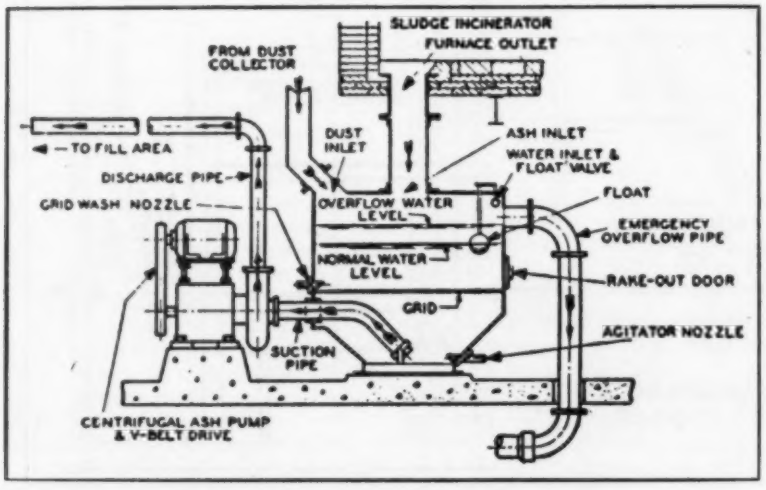


Fig. 2—CROSS SECTION of hydraulic ash hopper.

Mechanical Solids Handling

Mechanical handling of burned sludge ash has usually been done by discharging the ash continuously into a centrifugal-spaced bucket elevator, and continuously discharging the ash from the elevator into a storage bin. When furnace height is limited, a screw feeder, as shown in Fig. 4, may be used to feed the elevator boot. To keep elevator height to a minimum (and when bins are some distance from the elevator) horizontal screw conveyors may be used to convey ash to or from the elevator.

Photo courtesy Nichols Engineering

Fig. 4—BODY of bucket elevator being fed by screw feeder.

Horsepower requirements vary from 2 hp for an 8 x 5-inch elevator 60 ft. high handling 3 tons per hour to 5 hp for a 20 x 8-inch elevator handling 15 tons per hour.

Careful attention must be given the manner of furnace discharge as this usually determines elevator capacity required. Since the ash is dusty, it is desirable to keep elevator speeds to the minimum compatible with proper discharge. Perfect discharge type elevators which can operate at much lower speeds have been used in a few cases. However, their higher cost has limited their application in spite of less dust and lower maintenance.

Standard screw conveyors wear rapidly under burned ash handling service. Heavy duty sectional flights, sometimes further reinforced by stelliting, last much longer. To increase the life of bearings conservative design of capacity using not over ⅓ cross section area and also feed sections will help greatly. Conveyor troughs can easily be renewed and, therefore, in most cases liners are not used.

Pneumatic Handling

Pneumatic handling of burned sludge may be used. The normal advantages of pneumatic conveying are not realized unless continuous conveying of a uniform product can be achieved. In the flash drying type furnace the conveying system is of this type. On multiple hearth furnaces, however, where discharge is intermittent and the conveying system is not an integral part of the process, the cost of a continuous type pneumatic system and its high power requirements usually outweight any advantages over a mechanical handling system.

Intermittent type pneumatic conveying systems as shown in Fig. 5 have been used. In order to make them economically feasible both from a capital investment and power operating cost standpoint, the ash is usually stored for a period of an hour or two and then is conveyed in a system sized to handle the material in a few minutes. The nature of sewage ash is such that once it is stored it is hard to get moving freely from a hopper and this requires some manual attention to assure cleaning of hoppers. The power requirements vary from 15 hp for a small 4-in. system handling 2 to 5 tons per hour up to 60 hp for a 6-in system handling 12 tons per hour.

Storage

Storage bins are usually one of two types, circular steel with conical bottoms or glazed tile. If the temperature of the ash is expected to go over 600 or 700 degrees a steel bin will withstand the heat better. However, condensation may be a problem in cold climates in steel bins.

When discharging from bins into

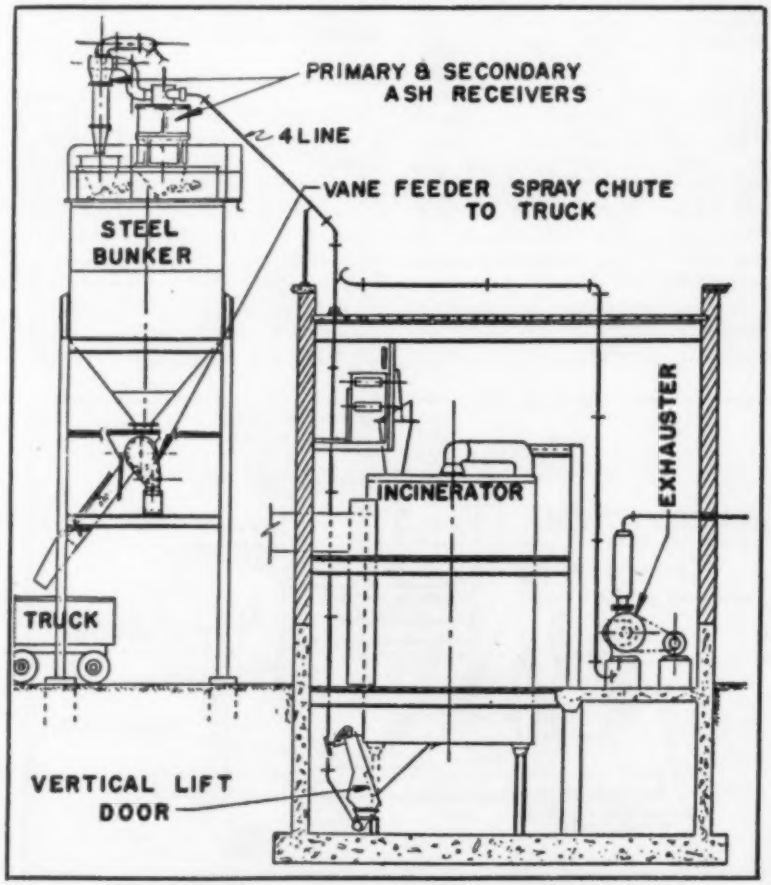


Fig. 5—PNEUMATIC systems handling burned sewage sludge solids.

trucks or railroad cars some provision must be made to hold down dust. Most plants use a rotary drum type mixer with internal water sprays. Once the operator regulates the water to suit the ash this is a very effective unit. To cut down cost some plants discharge dry into trucks using a gate or preferably a feeder to control the flow. A cloth or tarpaulin is usually spread over the truck body and this keeps dust to a minimum; these is still a dust problem when the truck is dumped at the fill area.

Costs and Power Requirements

The total cost for conveying equipment would vary with each installation due to capacity, hours of operation and availability of storage space. This is especially true when sludge is dried. Therefore, general costs for this type operation are not included. However, with respect to handling the ashes from burning the capital costs can be approximated and Table 1 gives an indication of what these costs would be for the various types of systems. The costs for the hydraulic system are complete, that is to the point of final disposal which would be a fill area on the plant site. However, with respect to the pneumatic or mechanical conveying systems the cost of trucking to a final disposal area has not been included and vary considerably for each location.

TABLE 1

Capital Costs and Power Requirements

Type System	Capital Cost per Ton of Dry Solids Burned/Day		Power Requirements KWH/Ton Burned	Remarks
Size Installation	Large	Small	All	All
Hydraulic	350	600	2.0	Conveys direct to final disposal area
Mechanical	500	1100	1.0	Add to these figures the cost of trucking to final disposal area
Pneumatic	600	1200	3.0	Add to these figures the cost of trucking to final disposal area

The power requirements are also given only for handling burned sludge solids. Here again the power requirements for hydraulic systems are for complete handling to the point of final disposal. For mechanical and pneumatic systems the operating power requirements derived from cost of trucking or other means of transportation to point of final disposal must be added.

Summary

For handling burned ash from sewage sludge incineration, the hydraulic type of system is preferable when adjacent land is available. If storage in a bin adjacent to the plant is desired, mechanical handling appears to be most foolproof at the present time. When handling dried sludge for use as fertilizer, the pneumatic system for the flash drying system and mechanical handling for multiple hearth furnace appears to be best.

First Year of Federal Aid in Sewage Treatment

The U. S. Public Health Service has announced that a total of $37,942,326 was granted to 446 municipalities to help them build sewage treatment plants during the first year of the new Federal water pollution control program.

To this amount, communities added $128,856,364, bringing the total estimated costs of the projects to $166,798,690.

As of July 1, a total of 1,075 applications for $97,889,447 in grants, with a total estimated construction cost of $677,131,972, were pending in the Public Health Service and State agencies.

Congress appropriated $50 million for the first year of the program and has authorized allocation among the States of a like sum during 1957. However each appropriation may be spent over a period of 2 years.

To be eligible for Federal funds, a municipal waste treatment project must be a part of a comprehensive control program. Grants are limited to 30 percent of the estimated project cost, or $250,000, whichever is less.

A breakdown of the first fiscal year's grants by States, with Federal contributions and total project costs, follows:

Alabama, six projects, total estimated cost, $5,536,651—Federal share, $1,108,000; *Arizona,* six projects, total estimated cost, $1,582,179—Federal share, $475,000; *Arkansas,* five projects, total estimated cost, $972,532—Federal share, $229,000; *California,* 23 projects, total stimated cost, $8,042,732—Federal share, $2,028,000; *Colorado,* five projects, total estimated cost, $2,613,016—Federal share, $623,000; *Connecticut,* three projects, total estimated cost, $2,734,650—Federal share, $537,000;

Delaware, one project, total estimated cost, $511,750—Federal share, $154,000; *District of Columbia,* one project, total estimated cost, $5,904,928—Federal share, $250,000; *Florida,* eight projects, total estimated cost, $2,512,981—Federal share, $681,000; *Georgia,* 11 projects, total estimated cost, $4,253,734 — Federal share, $1,063,000; *Idaho,* four projects, total estimated cost, $1,238,231—Federal share, $365,000; *Illinois,* 14 projects, total estimated cost, $6,615,182—Federal share, $1,604,000.

Indiana, 11 projects, total estimated cost, $3,662,954 — Federal share, $996,000; *Iowa,* 15 projects, total estimated cost, $3,835,582 — Federal share, $828,000; *Kansas,* 17 projects, total estimated cost, $3,150,266—Federal share, $734,000; *Kentucky,* eight projects, total estimated cost, $5,674,751—Federal share, $883,000; *Louisiana,* nine projects, total estimated cost, $3,344,459 — Federal share, $927,000; *Maine,* one project, total estimated cost, $735,000 — Federal share, $221,000.

Maryland, seven projects, total estimated cost, $2,491,709 — Federal share, $687,000; *Massachusetts,* six projects, total estimated cost, $2,364,829—Federal share, $687,000; *Michigan,* 11 projects, total estimated cost, $3,756,983 — Federal share, $1,127,000; *Minnesota,* 10 projects, total estimated cost, $3,201,063 — Federal share, $929,000; *Mississippi,* 11 projects, total estimated cost, $3,218,059—Federal share, $618,000; *Missouri,* 23 projects, total estimated cost, $4,018,398—Federal share, $1,042,000.

Montana, four projects, total estimated cost, $538,440—Federal share, $152,000; *Nebraska,* two projects, to-

(Continued on page 105A)

St. Joseph, Mo., Repairs its Main Sewers

Work now in progress on 13.36 miles of damaged sewers

by HARRY W. KURTZ

Mr. Kurtz is president of the Board of Public Works of St. Joseph, Mo. In this article he reports on the work done in his city to improve maintenance and operation of the sewer system.

IN 1950, when a new Board of Public Works came into office, a careful examination was made of all streets, sewers, bridges and city buildings. Many of them were found to be in a very bad state of repair. This condition was not necessarily caused by negligence, since during World War II and the Korean War material and money were so scarce that repairs were not made unless absolutely necessary.

Approximately five years ago, the Mayor and City Council asked that a citizens committee be organized to advise and consult with the administration on methods of financing and the selection of various projects which needed immediate attention. This committee was to be non-political, with members chosen from all walks of life. This committee was known as *Citizens for Improvements*. Membership was open to everyone in the city and the Committee elected its own officers. The Committee divided its membership into smaller groups, whose duties were to investigate various projects and report back to the Committee as a whole.

The General Committee decided that a bond election should be held. The following propositions were chosen to be put before the citizens of St. Joseph, in the order of importance or needs:

(1) $1,260,000 for resurfacing streets; (2) $1,000,000 for an entirely new street lighting system; (3) $64,000 for a new bridge over Dug Cut; (4) $1,433,000 for a public municipal coliseum and field; (5) $256,000 for improving existing and building new fire stations; (6) $14,000 for communication equipment for the Police Dept.; and (7) $473,000 for recreation purposes.

Much publicity was given the various projects, both by advertisements and public meetings. A large number of public indorsements were also published and several panel discussions were held by various groups.

A bond election was held on April 14, 1953 and Propositions 1, 2, 5, 6, and 7 passed. Propositions 3 and 4, while having a majority, failed to receive the two-thirds majority necessary for passage.

Bond Elections That Failed

Upon the advice of the City's bond attorney to employ a nationally known engineering firm to study the sewer situation in St. Joseph, the City employed Black and Veatch, Consulting Engineers, to prepare a report on the condition of the present main sewers and the needed extensions. This report, known as "Report on Long Range Sewerage Plan for St. Joseph, Missouri", was submitted to the City and the Citizens Committee in 1953. It had been decided not to submit the sewer bond election at the same time as the other seven propositions, due to the fact that it might confuse the voters and all propositions might fail; also, there was very strong opposition by one industrialist, as to the method of financing.

The City and the Citizens Committee decided to hold a special election on December 8, 1953, covering sewer improvements, as based on the Black and Veatch report. There were two propositions placed before the citizens at this election:

(1) $2,833,000 for extending, repairing, and improving the sanitary sewer system. (Bonds to be Revenue bonds.); (2) $3,350,000 for improving and extending the sanitary sewers (in this case, the district sewer system). These were to be General Obligation-Special Assessment Bonds, which would be levied against the property benefited. Under this proposition, the City would have been able to pay the contractor for district sewers in cash instead of by

TAKEN April 5, 1957. Headwall and wingwalls at outlet structure on Blacksnake Sewer after chipping of old rotten concrete and prior to placing mesh and guniting.

tax bills; property owners would repay the City over a ten- to twenty-year period, at a considerably lower rate of interest than required by the tax bill method.

At present, contractors protect themselves from bad property and non-payment of tax bills by increasing their bids so that the good property pays the bills. In some districts the prices are advanced 50 percent or more over the price if paid in cash. In fact, no bids have been received on proposed sewers when advertised.

Both propositions were badly defeated at the December 8, 1953 election. This was due to the fact that the opposition clouded the issues to such an extent that the public voted them down, despite extensive publicity and advertisements explaining exactly what would be accomplished and accompanying savings to taxpayers.

Better Luck in 1955— Sewer Repair Funds Voted

In 1955, the Citizens Committee, now known as the *Citizens Improvement Association*, and the City administration decided to call for another bond election for sewer extensions and repairs, and a smaller amount for financing the district sewers.

It was decided to hold an election on November 15, 1955 on the following propositions:
(1) $500,000 for repairs to the main sewers; (2) $2,000,000 for main sewer extensions (G. O. Bonds); (3) $500,000 for financing the district sewers for a period of five or six years on the basis of cash payments to the contractor, instead of by the regular method of paying the contractor with tax bills. These were to be General Obligation Special Assessment Bonds. Those benefited would pay the City back over a period of years.

This time the City was divided into eleven different sections. A diagnosis of each section was published showing what repairs were needed and what the proposed extensions were in that section; also, the Committee had pertinent questions and answers published over a long period. Much publicity was also given by speakers at club meetings, and over radio and television.

At the November 15, 1955 election, Proposition 1, in the amount of $500,000 for main sewer repairs, was the only one that carried.

Bids Taken and Contract Awarded

The sewer system of St. Joseph is a combination system, including both storm water and sanitary sewage in the same sewer. Large sewers were built in practically the same location as existing creeks, which they replaced. Most of these sewers are named the same as the creeks. It is a gravity system and there are no lift stations in the present system. There are 18 sewers which enter the Missouri River along its water front.

DOWNSTREAM. Taken April 5, 1957. Shows brick missing in crown of Mitchell Ave. sewer, 30° East of Burlington Track No. 6.

In the Black and Veatch report of 1953, needed sewer repairs were outlined; the City requested Black and Veatch to prepare plans and specifications for repairing the sewers. Bonds in the amount of $300,000 were sold soon after the election. The City received bids on the following items:

(1) Sandblasting; (2) Removal of old concrete; (3) Removal of old brick work; (4) Reinforcing bars in place; (5) Wire mesh in place; (6) Gunite in place; (7) Diversion of water; (8) Removal of solid debris from within sewer.

Six bids were received by the City on September 28, 1956. We were fortunate in attracting several of the largest contractors doing this type of construction in the United States.

Pressure Concrete Co. Successful Bidder

On October 3, 1956, the Board of Public Works awarded the contract to the Pressure Concrete Company of Florence, Alabama, who had submitted the lowest bid. Their contract called for the repair of the following sewers:

Blacksnake Sewer: Size at outlet, 17 ft. x 14½ ft. Size at intake, 12 ft. diameter. Approximately 2½ miles in length. Part concrete and part brick. Sewer was in very bad state of repair. Concrete in many places had disintegrated to a depth of one foot; also, at many places the reinforcing was exposed. At one place under the Chicago Great Western Railway tracks, there was a crack in the sewer top approximately 2 inches wide and one side had dropped about 6 inches below the other. This was repaired by placing reinforced bars, mesh, and guniting.

Bush Creek Sewer: An old brick sewer 6 ft. in diameter at junction with the Charles Street sewer and 4 ft. at north terminus. Approximately 0.81 miles in length. In several places at least two courses of brick had fallen out. Repaired by wire mesh anchored to brick work and gunited flush with good brick work.

Smith's Branch of Charles Street Sewer System: Nine ft. in diameter at River and 42 in. at terminus. Approximately 2.54 miles in length.

Mitchell Avenue Sewer: Fourteen

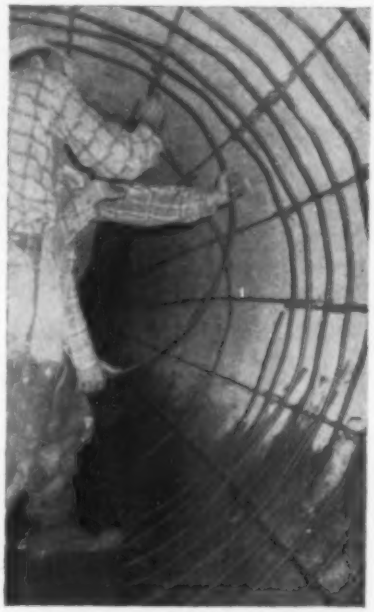
Mar. 1957. PARTIAL dewatering of section of invert necessary for repair in Mitchell Ave. sewer.

feet in diameter at River. One section eggshape 15 ft. x 13 ft. and upper reach 10½ ft. horse shoe shape. This sewer runs under Union Station and all the tracks that serve the Union Station. It is an old sewer and was in a bad state of repair, especially under the Depot tracks and Depot. This was repaired by sandblashing and removal of all loose brick, reinforcing the sewer with complete bar grid and mesh, and guniting until all holes, rods and mesh were encased. Total length of job—approximately 3.5 miles.

Oak Hill Sewer: A concrete sewer tributary to Mitchell Avenue Sewer. Crown of sewer near 28th Street was cracked and sagged approximately 6 in. for a distance of 150 ft. This was repaired by a bar grid, with mesh around the entire perimeter and guniting. Also, at one place near 30th Street, the crown was cracked and sagging for a distance of 200 ft.; this was repaired by the same method. Eight ft. in diameter at Junction to 6 ft. diameter at east terminus.

Nineteenth Street Sewer: This is a 48 in. brick sewer. For approximately 100 ft most of the bricks are out in the invert. This will be repaired by cleaning it out and applying reinforced gunite.

Whitehead Sewer: This is a large sewer. At its west end near South 6th Street it is 14 ft x 16½ ft for 2400 ft east to 11th Street. From 11th St. to 17th Street it is 16 ft diameter, a distance of 2300 ft. From 17th Street to 24th Street it is 10 ft diameter, a distance of 2200 ft. At 17th Street, a 16 ft diameter stub enters the main sewer from the southeast. This stub was built for the purpose of continuing the main sewer at some future date to drain storm water from a very large drainage area.



Jan. 1957. PLACING of reinforcement in Oak Hill Sewer.

Jan. 1957. TEMPORARY dam, 6-in. dewatering pipe in Oak Hill sewer prior to repair of invert.

There were several places that had spalled and one or two places where the crown had developed narrow cracks. The head walls had spalled. All were repaired by reinforced gunite.

Stockyards Sewer: This sewer drains a large portion of the south end of town. It also carries off a portion of the stockyards and packing house sewage and is 8 ft in diameter. There is considerable deterioration within this sewer and in many places the reinforcing is exposed. Below the junction of the sewer coming from the stockyards and packing plants the sewer and exposed reinforcing bars are coated with grease and slime. Also, in the afternoon (approximately two to three p.m.) the packing plants wash down with steam and hot water. It will be necessary for the contractor to use special care in cleaning the walls and rods; they might have to stop work entirely during the flow of hot water, or possibly might have to repair this sewer at night, when the flow of sewage is reduced.

TAKEN April 5, 1957. Shows mesh and reinforcing in approximately 1-ft deep hole in the concrete section at the outlet of Blacksnake sewer. Mr. W. Smith, Chief City Inspector.

The total mileage of sewers to be repaired under this contract is 13.36 miles. There are 36.79 miles or main sewers and 157.92 miles of district sewers within the city limits of St. Joseph.

The city personnel is as follows: Harry W. Kurtz, President, Board of Public Works; Robert B. Graff, Member, Board of Public Works; Wm. A. Lorenz, Member, Board of Public Works; Glen B. Riddle, City Engineer; Gus Koulas, Resident Engineer, Black and Veatch; Charles W. Smith, Chief Inspector, City Engr. Dept; Paul VanCleave, Inspector, City Engr. Dept.

SECTION of Blacksnake Sewer, between Main Street and McArthur Drive, Jule Street & Isadore Street (Shooting Gunite into cavity on sidewall of invert)

Unique Sewer Repair

Epoxy resin and glass fibre laminated patch used to mend break in Los Angeles sewer

by E. G. STUDLEY and R. L. WHITE

Mr. Studley is Division Engineer, Sewer Design Division, Bureau of Engineering, City of Los Angeles. Mr. White is a Civil Engineer in the Sewer Design Division.

DURING MARCH, 1957, while drilling caissons for a factory foundation in Los Angeles, a cast-in-place semi-elliptical concrete sewer 4 ft 9 in. in diameter was inadvertently pierced by the building contractor's caisson drilling tool. The damaged sewer serves the entire Fernando Valley section of Los Angeles and, in addition, the tributary cities of San Fernando, Burbank and Glendale. Constructed in 1926 of non-reinforced concrete, the sewer's interior periphery above the spring line is lined with clay liner plates.

Subsequent excavation of about 15 feet of earth cover at the site of the damage revealed a hole approximately 16x20 in. in size on one side of the conduit about half way between the spring line and the soffit. In considering the various possible methods of repair, the restoration of the protection liner on the inside was of particular concern because of the corrosive sulfide characteristics of the tributary sewage. Examination of the hole also revealed that the interior clay liner plates were splintered along the inside edge of the hole; it appeared impractical to attempt to adequately restore the damage by casting new clay liner plates in the opening. Further complicating factors were that all work had to be performed from the outside because the sewer would necessarily remain in operation, and that the high water surface at times of peak flow coincided with the lower edge of the hole.

Prior to the damage, testing of glass fibre laminates and epoxy resins had been undertaken by the Bureau of Standards of the City of Los Angeles. Based on test results, it was concluded that these materials would be both permanent and corrosion-resistant when used within the corrosive atmosphere of sewers.

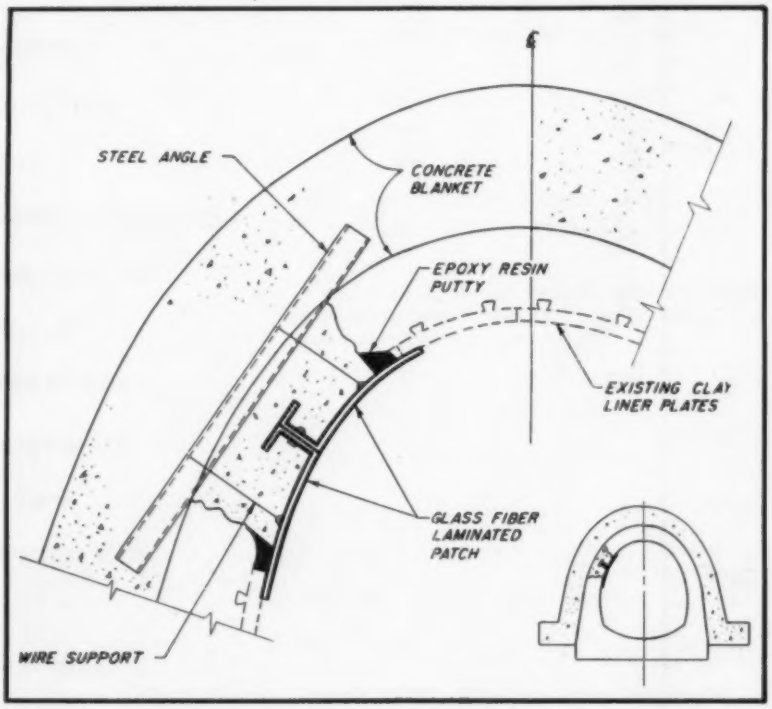
Repair procedure

The damaged section was repaired by first chipping away all loose and shattered concrete. The surfaces of the adjacent clay liner plates for a distance of 4 inches from the inside edge of the hole were cleaned with a wire brush until all visible foreign material had been removed. These surfaces were then washed with carbon tetrachloride and wiped with acetone to speed up the drying time. One coat of epoxy resin was applied to the prepared inside clay liner surface. The two separate pieces of the glass fibre laminated patch, each appropriately curved to meet the inside configuration of the sewer, were inserted and bolted together through adjoining molded L-sections. After being firmly secured together, the patch was then pulled up tightly against the interior surface of the sewer, and the joint between the concrete and the patch packed with epoxy resin putty.

Because of flow conditions, it was necessary to pursue the repair at night during the period of low flow. To further accelerate the curing of the epoxy resin putty, hot air guns and heat lamps were used. After the epoxy resin putty had taken its initial set, concrete was poured to restore the conduit shell. Because of longitudinal cracks in the arch, it was deemed necessary to place a concrete blanket around the sewer for a distance of approximately 10 feet.

It is believed that the materials and methods used in this repair offer considerable promise for other applications.

This repair was accomplished under city inspection, without cost to the city, in accordance with plans approved by Lyall A. Pardee, City Engineer, and Merrill Butler, Deputy Engineer of Design.



CROSS SECTION and detail of restored sewer

Solubility of Oxygen in Water

A nomograph

by D. S. DAVIS
Professor of Engineering
University of Alabama
Tuscaloosa, Ala.

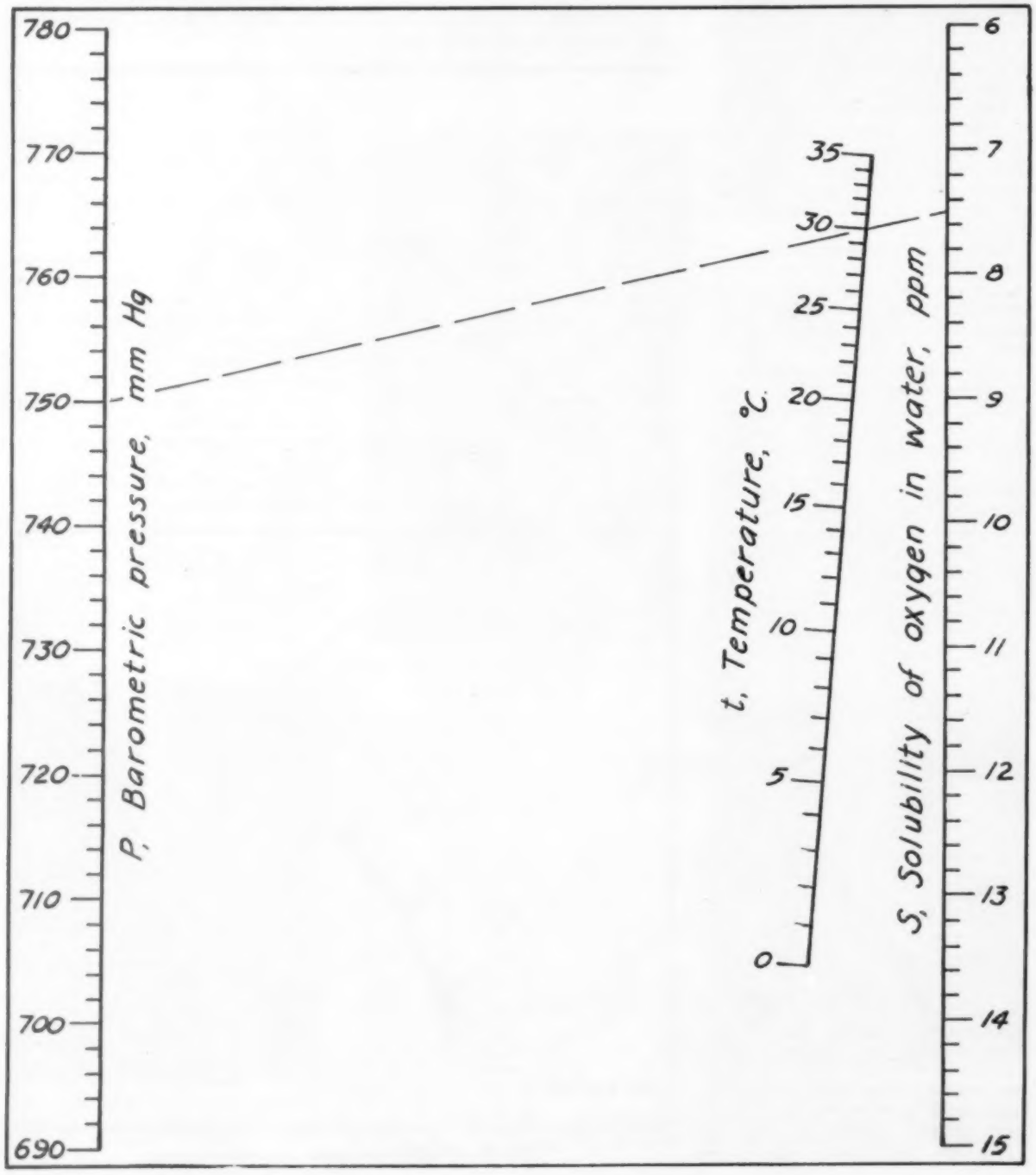
FOR THE SOLUBILITY of atmospheric oxygen in water at temperatures between 0° and 35° C, Hatfield[2] gives the equation

$$S = \frac{0.678\ (P-\mu)}{t + 35}$$

where

S = solubility of oxygen in ppm
P = barometric press. in mm of mercury
μ = vapor pressure of water at t° C.

The nomograph, constructed through recourse to line coordinate methods[1], enables rapid and accurate solution of the equation. The use of the chart is illustrated as follows: What is the solubility of oxygen in water at 30° C, in equilibrium with air, when the barometric pressure is 750 mm of mercury? Connect 750 on the P-scale and 30 on the t-scale with a straight line. Note the intersection with the S-scale at solubility of 7.5 ppm of oxygen.



References

(1) Davis, D. S., "Nomography and Empirical Equations," Chap. 10, Reinhold Publishing Corporation, 1955.

(2) Hatfield, W. D., Sewage Works Journal, p. 557, May, 1941.

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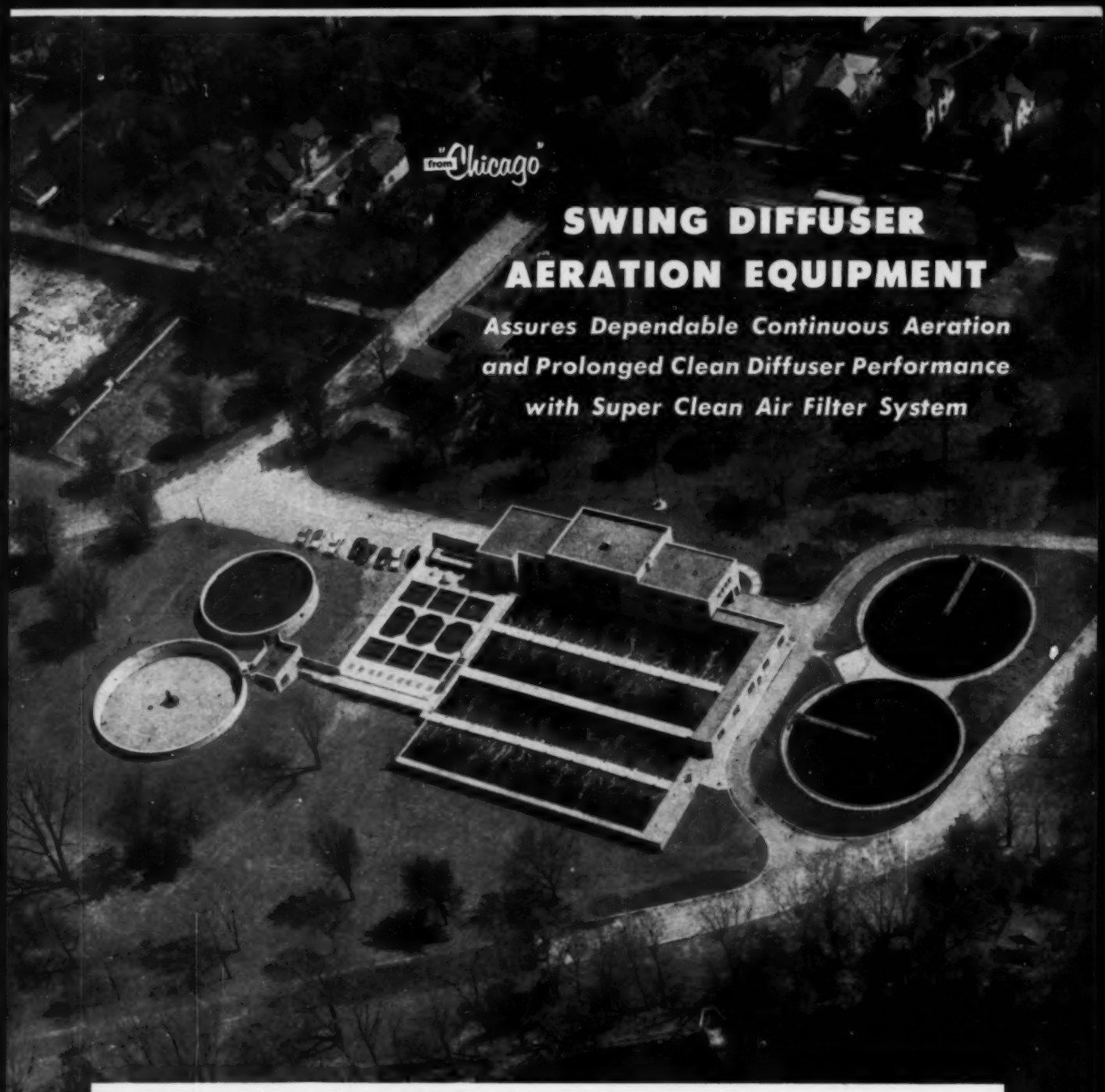

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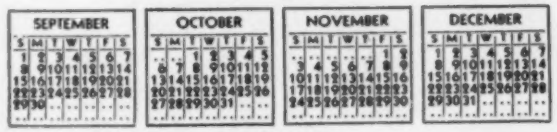
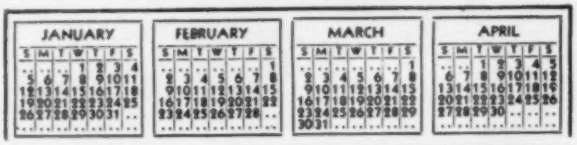


1958



Oct. 7-10—Boston, Mass. *(Hotel Statler)*
FEDERATION OF SEWAGE & INDUSTRIAL WASTES ASSNS., Ralph E. Fuhrman, Exec. Secy., 4435 Wisconsin Ave., N. W., Washington 16, D. C.

Oct. 8-11—Atlantic City, N. J. *(Chalfonte Hotel)*
PENNSYLVANIA WATER WORKS ASSN., Secy., David Dunlap, 2609 N. Second St., Harrisburg, Pa.

Oct. 10—South Paris, Maine.
MAINE WATER UTILITIES ASSN., Secy., Gerard F. Laurin, 89 Western Ave., Augusta, Maine

Oct. 13-16—Oklahoma City, Okla. *(Municipal Auditorium)*
SOUTHWEST SECTION, A.W.W.A., Secy., Leslie A. Jackson, Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

Oct. 14-18—New York, N. Y. *(Hotel Statler)*
AMERICAN SOCIETY OF CIVIL ENGINEERS, Exec. Secy., W. H. Wiseley, 33 W. 39th Street, New York 18, N. Y.

Oct. 16-18—Des Moines, Iowa *(Fort Des Moines Hotel)*
IOWA SECTION, A.W.W.A., Secy. J. J. Hail, Supt., Water Dept., City Hall, Dubuque, Iowa.

Oct. 17-18—Halifax, Nova Scotia *(Nova Scotian Hotel)*
CANADIAN SECTION, A.W.W.A. 10th Annual Meeting—Maritime Branch, Secy. J. D. Kline, Pub. Service Comm., P. O. Box 608, Halifax, N. S.

Oct. 20-23—Biloxi, Miss. *(Buena Vista Hotel)*
ALABAMA-MISSISSIPPI SECTION, A.W.W.A., Secy., C. M. Mathews, Asst. Supt., Public Service Comm., 19 West Commericial Street, Yazoo City, Miss.

Oct. 21-23—Pittsburgh, Pa. *(Hotel Penn Sheraton)*
18TH ANNUAL WATER CONFERENCE, Secy., W. M. Porter, Engineers' Society of Western Pennsylvania, Hotel Penn Sheraton, Pittsburgh 30, Pa.

Oct. 23-24—Wheeling, W. Va. *(McLure Hotel)*
WEST VIRGINIA SECTION, A.W.W.A., Secy., Hugh W. Hetzer, Engr., West Va. Water Service Co., P. O. Box 1906, Charleston 27, W. Va.

(Jointly With)
WEST VIRGINIA SEWAGE & INDUSTRIAL ASSN., Secy., G. O. Fortney, c/o State Dept. of Health, Charleston 5, W. Va.

Oct. 24-26—Atlantic City, N. J. *(Hotel Madison)*
NEW JERSEY SECTION, A.W.W.A., Secy., Albert F. Pleibel, 683 Prospect Street, Maplewood, N. J.

Oct. 25-26—Seattle, Wash. *(Franklin Hotel)*
PACIFIC NORTHWEST SEWAGE & INDUSTRIAL WATER ASSN., Secy., Gilbert H. Dunstan, State College of Washington, P. O. Box 176, Pullman, Wash.

Oct. 28-30—Toronto, Ontario *(King Edward Hotel)*
CANADIAN INSTITUTE ON SEWAGE & SANITARY, Secy., Dr. A. E. Berry, Administrative Office, 72 Grenville St., Toronto, Ontario, Canada.

Oct. 28-31—Pullman, Wash. *(Washington State College)*
HYDRAULICS CONFERENCE AND AM. GEOPHYSICAL UNION (Joint Meeting), E. Roy Tinney, Chmn. Planning Comm., Washington State College, Pullman, Wash.

Oct. 29—Nov. 1—San Jose, Calif. *(Civic Auditorium)*
CALIFORNIA SECTION, A.W.W.A., Secy., Henry J. Ongerth, Bureau of San. Engr., 905 Contra Ave., Berkeley 7, Calif.

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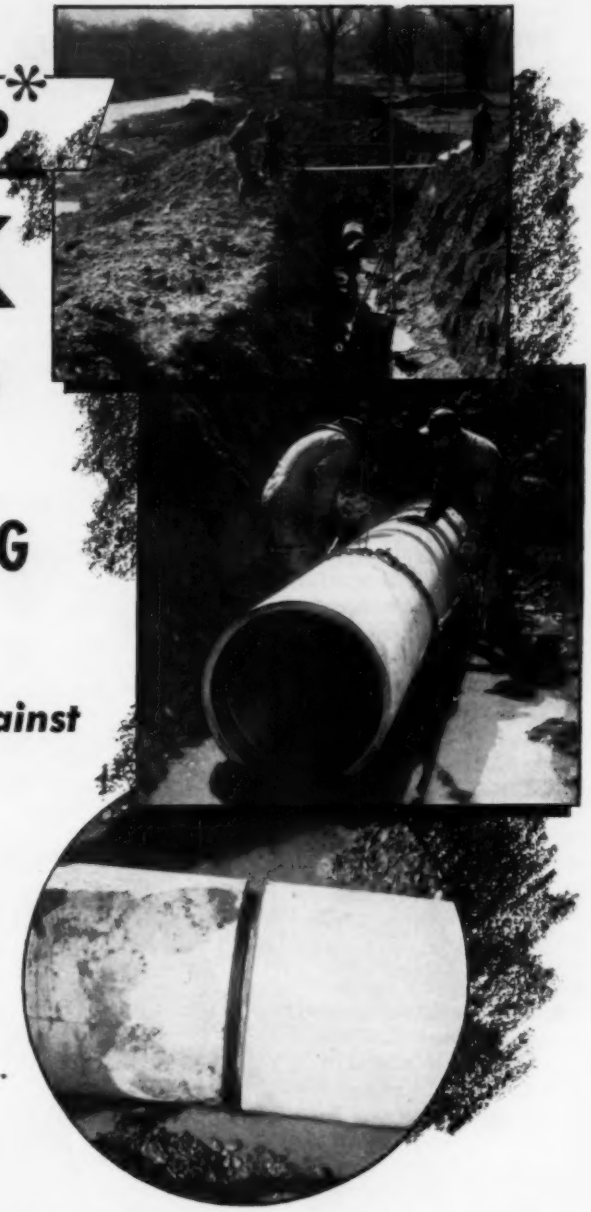


Engineers had their eyes on future as well as present costs when they designed Canton's recent sewer expansion project. Here's how their call for TYLOX-jointed, REXON-coated concrete pipe helps assure Canton citizens of "most for the money" from their tax dollar . . .

NO JOINT LEAKS – even under tough conditions like those shown in the top photo. TYLOX prevents infiltration . . . keeps treatment plant loads at a minimum . . . eliminates root and sediment penetration.

NO ACID ATTACK – even though industrial wastes may enter the line. REXON Coating (center photo) is resistant to virtually all acids, alkalies, greases and solvents. "Teamed up" with equally durable TYLOX Joints, the resulting line is corrosion-resistant *throughout*.

FAST PIPE-LAYING – Just shove gasketed pipe home (lower photo) and the TYLOX Joint is complete. Wet trenches do not delay the work, and the *flexible* TYLOX permits immediate backfilling.

Plan now to specify TYLOX Rubber Joints and REXON Pipe Coating on your next concrete pipe job and be assured of leakproof, corrosion-resistant lines laid faster . . . Write for more details today.

* **PROJECT:** Stark County sewer expansion project, Canton, Ohio
ENGINEER: A. T. Holl, Stark County Sanitary Engineer
CONTRACTOR: Shullo Construction Co., Akron, Ohio
PIPE: Reinforced concrete, TYLOX-Jointed and REXON Coated, manufactured by United States Concrete Pipe Company, Cleveland, Ohio.

5062

HAMILTON KENT MANUFACTURING COMPANY
KENT, OHIO
427 West Grant St. ORchard 3-9555

No chance for trouble with a WEINMAN Non-Clogging Centrifugal Unipump on the job!

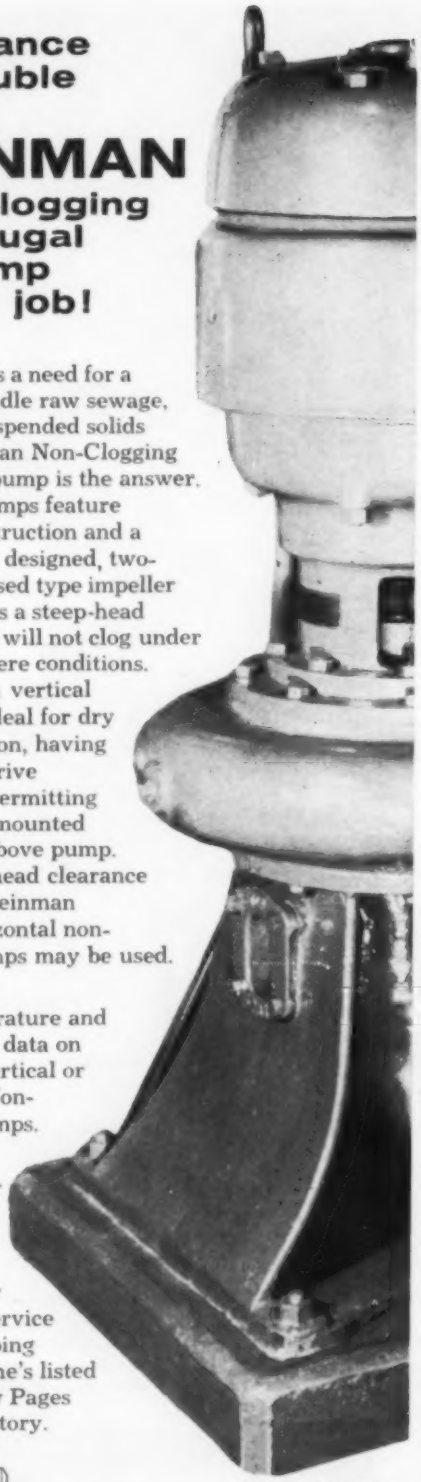
- When there's a need for a pump to handle raw sewage, sludge or suspended solids . . . a Weinman Non-Clogging centrifugal pump is the answer.

  These pumps feature rugged construction and a scientifically designed, two-vaned, enclosed type impeller that produces a steep-head capacity and will not clog under the most severe conditions.

  Weinman vertical pumps are ideal for dry pit installation, having a flexible drive connection permitting motor to be mounted any height above pump. Where overhead clearance is limited, Weinman Class B horizontal non-clogging pumps may be used.

- Send for literature and performance data on Weinman Vertical or Horizontal Non-Clogging pumps.

- Contact your nearest Weinman Pump Specialist for immediate service on any pumping problem . . . he's listed in the Yellow Pages of your directory.



Weinman Class VM Vertical Non-Clogging Unipump with close-coupled motor drive.

Find your nearest representative in the 'Yellow Pages'

THE WEINMAN PUMP MFG CO
290 SPRUCE ST. COLUMBUS 8, OHIO

Oct. 30-Nov. 1—Washington, D. C. *(Sheraton-Park Hotel)*
CHESAPEAKE SECTION, A.W.W.A., Secy., Carl J. Lauter, 6955—33rd St., N.W., Washington 15, D. C.

Nov. 6-8—Roanoke, Va. *(Hotel Roanoke)*
VIRGINIA SECTION, A.W.W.A., Secy. J. P. Kavanagh, District Manager, Wallace & Tiernan, Inc., 213 Carlton Terrace Bldg., Roanoke, Va.

Nov. 7-8—Hastings, Neb. *(Clark Hotel)*
NEBRASKA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., V. J. Lechtenberg, 614 Standard Oil Bldg., Omaha, Neb.

Nov. 10-13—Jacksonville, Fla. *(Roosevelt Hotel)*
FLORIDA SECTION, A.W.W.A., Secy., Jay D. Roth, Mgr., Water Dept. & City Shops, Bin O, Miami Beach 39, Fla.

Nov. 11-13—Raleigh, N. C. *(Hotel Sir Walter)*
NORTH CAROLINA SECTION, A.W.W.A., AND NORTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSN., Joint Meeting, Secy. Wilbur E. Long, Jr., 1615 Bickett Blvd., Raleigh, N. C.

Nov. 11-15—Cleveland, Ohio
AMERICAN PUBLIC HEALTH ASSOCIATION, 85th Annual Meeting, Exec. Director, Dr. Reginald M. Atwater, 1790 Broadway, New York 19, N. Y.

Nov. 15—Columbia, S. C. *(Jefferson Hotel)*
SOUTH CAROLINA WATER & SEWAGE WORKS ASSN., Secy., W. G. Crosby, State Board of Health, Columbia, S. C.

Nov. 18-22—Stillwater, Okla. *(Oklahoma A & M College)*
OKLAHOMA WATER & SEWAGE SHORT COURSE, Prof. Quintin B. Graves, Oklahoma A & M College, Stillwater, Okla.

Nov. 21—Boston, Mass. *(Hotel Statler)*
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

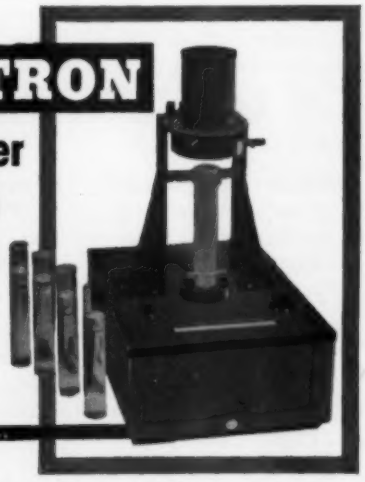
Dec. 1-6—New York, N. Y.
AMERICAN SOCIETY MECHANICAL ENGINEERS, 29 West 39th Street, New York, N. Y.

Dec. 8-11—Chicago, Ill. *(Conrad Hilton Hotel)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Annual Meeting Secy. F. J. Van Antwerpen, 25 West 45th Street, New York 36, N. Y.

Dec. 12—Augusta, Maine.
MAINE WATER UTILITIES ASSN., Secy., Gerard F. Laurin, 89 Western Ave., Augusta, Maine

Dec. 19—Boston, Mass. *(Hotel Statler)*
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

LUMETRON Colorimeter Mod. 450 for Nessler Tubes



A new photoelectric instrument of high accuracy for the measurement of pale colors and faint turbidities.

- **For all analytical colorimetric determinations in which only a slight coloration can be developed.**
- **For sanitary examination of drinkable water and for analysis of water for municipal and industrial purposes.**
- **For color standardization of lightly colored liquids such as kerosenes, sugar solutions, solvents, varnishes, liquid waxes, vegetable oils, beverages, cosmetics.**
- **Replaces visual color comparison in Nessler tubes.**

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PHOTOVOLT CORPORATION
95 Madison Ave. New York 16, N. Y.

W&SW

Spillway

OVERFLOW FROM THE MAIN SECTION

(Continuedf rom page 473)

tal estimated cost, $313,185—Federal share, $94,000; *Nevada,* two projects, total estimated cost, $491,000—Federal share, $147,000; *New Hampshire,* four projects, total estimated cost,$1,043,330—Federal share,$313,000; *New Jersey,* six projects, total estimated cost, $3,936,467 — Federal share, $954,000; *New Mexico,* 10 projects, total estimated cost, $2,123,695—Federal share, $603,000.

New York, 20 projects, total estimated cost, $12,064,853 — Federal share, $2,387,000; *North Carolina,* 12 projects, total estimated cost, $6,475,698 — Federal share, $1,271,000; *North Dakota,* 19 projects, total estimated cost, $1,081,946 — Federal share, $321,000; *Ohio,* 15 projects, total estimated cost, $5,346,088—Federal share, $1,601,000; *Oklahoma,* 14 projects, total estimated cost, $4,672,368—Federal share, $865,000; *Oregon,* 11 projects, total estimated cost, $2,727,297—Federal share, $645,000.

Pennsylvania, 11 projects, total estimated cost, $10,783,904 — Federal share, $2,080,000; *Rhode Island,* three projects, total estimated cost, $1,302,080—Federal share, $378,000; *South Carolina,* eight projects, total estimated cost, $2,648,636 — Federal share, $767,000; *South Dakota,* 11 projects, total estimated cost, $1,987,863—Federal share, $408,000; *Tennessee,* six projects, total estimated cost, $4,177,626 — Federal share, $1,067,000; *Texas,* 20 projects, total estimated cost, $7,037,684—Federal share, $1,656,000.

Vermont, two projects, total estimated cost, $641,140—Federal share, $192,000; *Virginia,* seven projects, total estimated cost, $2,701,740—Federal share, $240,000; *Washington,* 13 projects, total estimated cost, $2,486,270—Federal share, $746,000; *Wisconsin,* 14 projects, total estimated cost,$4,110,611—Federal share,$955,000; *Wyoming,* six projects, total estimated cost, $1,940,920 — Federal share, $416,000; *Hawaii,* one project, total estimated cost, $165,000—Federal share, $50,000; *Puerto Rico,* nine projects, total estimated cost, $4,028,230—Federal share, $838,000.

Pamphlets and Booklets Available

Among the recent pamphlets and books which have become available are the following:

"Principles of Water Rights Law in Ohio". This 34-page booklet has been prepared by Charles C. Callahan, College of Law of the Ohio State Univ., with a preface by C. V. Youngquist, Chief of Div. of Water of Ohio's Dept. of Natural Resources. The book was prepared in cooperation with the Ohio University and the Ohio Dept. of Natural Resources from which it may be obtained. The book includes information on the disposal of rainfall, water use in damage, nature of the problems, the general theory of water rights, legal classification of waters.

There is also a discussion of doctrine of prior appropriation vs. the doctrine of riparian rights in streams, as well as the use of water, types of use, meaning of reasonable use, lands on which water is used, types of riparian owners, waters to which the doctrine applies, etc. There is also a section on diffused surface water as well as underground water.

Any persons interested in the principles of water rights law should certainly have this book in his library.

* * *

"The Chemical Industry Facts Book". A 160-page basic reference work on the chemical industry contains 15 chapters ranging from "The Industry's Role in the Economy" to such specifics as "Chemicals and Nuclear Energy". The book is adequately illustrated with charts, graphs, tables and other updated information. This is the third edition. This book, published by the Manufacturing Chemists.

STATEMENT OF OWNERSHIP

Statement required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) showing the ownership, management and circulation of

Water & Sewage Works

published monthly at Pontiac, Illinois, for September, 1957.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Edward Scranton Gillette, 185 North Wabash Ave., Chicago 1, Illinois; Editor, Linn H. Enslow, 155 East 44th Street, New York 17, N. Y.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Scranton Publishing Co., Inc., 185 North Wabash Ave., Chicago 1, Ill.; E. S. Gillette, 185 North Wabash Ave., Chicago 1, Ill.; C. T. Gillette, 185 North Wabash Ave., Chicago 1, Ill.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securties are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Edward S. Gillette, Publisher

Sworn to and subscribed before me this 12th day of September, 1957. Helen Buford Hoppe, Notary Public. (My commission expires March 19, 1960.)

"Dictionary of Micro-Biology" by Jacobs, Gerstein & Walter. This book has been designed for the needs of persons interested in the science of micro-biology including barteriologists, psychologists, immunologists, micologists, physicians, veterinarians, chemists and others. The book contains more than 5000 individual entries and is both a dictionary and a glossary. It is a ready reference book which gives information on the classification, motility, morphology, physiology and cultural characteristics, habitat, differentation, etc., of any given organism.

The book was authored by Morris B. Jacobs, Director of Bureau of Laboratory, Dept. of Air Pollution Control in New York City, with Morris Gernstein, now assistant chemist of the Dept. of Air Pollution Control of New York City and William G. Walter, Prof. of Bacteriology in Montana State College. The 276-page book retails for $6.75 and may be obtained from D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J.

* * *

"Water Pollution Research, 1956". This is a report of the Water Pollution Research Board with the Report of the Director of Water Pollution Research Laboratory in England. This 76-page booklet includes information on the survey of the Thames Estuary, oxygen balance in surface waters, effect of pollution on fish, volume and strength of sewage, method of treatment of sewage containing synthetic detergents, adsorption of oxygen on percolating filters, biological films, industrial waste waters, their composition and treatment, recharge of underground water supplies and automatic equipment for recording dissolved oxygen or the delivery of small volume of liquid.

This is another in the series of annual reports on water pollution research of the Dept. of Scientific and Industrial Research in England. The book may be obtained for 77 cents from the British Information Services, 45 Rockefeller Plaza, New York 20, N. Y.

* * *

Solar Distillation of Sea Water Being Given Large Scale Test

A large scale test of the economy and practicability of sea water distillation, as a measure for the production of fresh water from sea water or other salt water sources, is being financed by the Interior Dept. of the U. S. Government.

The pilot plant, with an anticipated conversion of 500 gpd, is to be located on a 5-acre site near San Diego, Calif., owned by the city of San Diego. The solar still will resemble a green-house with a series of saucer-like concrete slabs under the glass enclosure. The rays of the sun evaporate the salt water. The vapor condenses on the glass walls and sloping top of the green-house, and trickles into the catchment troughs. The water so produced is expected to cost somewhere between 50 cents and 75 cents per 1000 gals. of potable water produced.

Directory of Consultants Available

The 16th edition of "Consulting Services" 1957; published by the Association of Consulting Chemists and Chemical Engineers, Inc., containing 136 pages (6x9), is now available. $1 per copy.

It offers information and directions for finding the right consultant to solve problems of manufacture, process improvements, research and development, plant designs and analytical and testing work in all its modern aspects.

(Continued on page 109A)

The largest water tank repair company in the United States is at your service. Repairs guaranteed for 12 years—paint for 3 years.

Representatives in every state of the Union.

DIXIE TANK'S "SYMBOL" OF YOUR PROTECTION

DIXIE TANK & BRIDGE CO.

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Please write or wire us for more information.

WATER & SEWAGE WORKS

See.... the important PRODUCTS *and* SERVICES information in the *new* R&D.. *out Now!*

Turn the page for the list of companies having information of interest to you in the 1957-58 ISSUE of THE REFERENCE and DATA NUMBER

REFERENCE *and* DATA NUMBER

JUNE 1, 1957

These firms have information on products and Services for the Water Supply and Sewage Disposal Market in the 1957-58 REFERENCE *and* DATA NUMBER of WATER & SEWAGE WORKS

Airkem, Inc.
Alabama Pipe Co.
Allis-Chalmers
Amercoat Corp.
American Vitrified Prod. Co.
American Well Works
Anthracite Equipment Co.

Bailey Meter Co.
Beaumont Birch Co.
Bethlehem Steel Co.
B-I-F Industries, Inc.
Borden Metal Products Co.
Builders-Providence Inc.
Byron Jackson Pumps, Inc.

Chain Belt Co.
Chicago Bridge & Iron Co.
Chicago Pump Co.
Clarksville Foundry & Machine Works
Jas. B. Clow & Sons (Iowa)
R. D. Cole Mfg. Co.
Columbia Southern Chem. Co.
Combustion Engineering, Inc.
Cook Well Strainer Co.

Dorr-Oliver, Inc.

Fischer & Porter Co.
Foster Engineering Co.

General Chem. Div.
Allied Chem. & Dye Corp.
General Filter Co.
Golden-Anderson Specialty Valve Co.
Graver Tank & Mfg. Co.
Graver Water Conditioning Co., Inc.

Hardinge Co., Inc.

Infilco, Inc.
Ingalls Iron Works Co.
International Minerals & Chemical Corp.
Iowa Valve Co.

Jeffrey Mfg. Co.
Johns-Manville
John Wiley Jones Co.

Komline-Sanderson Engineering Corp.

Link-Belt Co.
Ludlow-Rensselaer Valve Mfg. Co.

M & H Valve & Fittings Co.
Millipore Filter Corp.
Morse Boulger Destructor Co.
Multiplex Mfg. Co.

Natco Corp.
National Clay Pipe Mfrs., Inc.
National Power Rodding Corp.
Neptune Meter Co.
Nichols Engineering & Research Corp.

Olin-Mathieson Chemical Co.
Omega Machine Co.

Pacific Flush Tank Co.
Pennsalt Chemical Corp. (Western Div.)
Permutit Co.
Phipps & Bird, Inc.
Henry Pratt Co.
Presstite-Keystone Engineering Products Co.
Pressure Concrete Co.
Proportioneers, Inc.

Rensselaer Valve Co.
Roberts Filter Mfg. Co.

Schramm, Inc.
Simplex Valve & Meter Co.
Smith & Loveless, Inc.
S. Morgan Smith Co.
A. P. Smith Mfg. Co., Inc.

Tennessee Corp.

U. S. Pipe & Foundry Co.

Walker Process Equipment, Inc.
Wallace & Tiernan, Inc.
Washington Aluminum Co.
Water Seals, Inc.
Western Machinery Co.
White Diesel Engine Div.
Worthington Corp.

Yeomans Bros. Co.

Table of Contents, Foreword and a page, entitled "How to Find Your Consultant" precede three sections as follows:

Section I. *Classifier.* This section contains over 200 items of activity, with the members specializing or qualifying in the given field indicated by key numbers, which correspond with the scope pages in Section II.

Section II. *Scope pages.* These describe page by page each member's qualifications and activities.

Section III. *Alphabetical index.* Including names of organizations with which members are affiliated, geographical location, including branch offices.

Send *letterhead requests* with *remittance* of $1.00 per copy to ACC & CE Inc., Rm. 82, 50 East 41st St., New York 17, giving *source of reference, name of person and company,* and *complete address* including *postal zone number.*

Symposium Planned in Saline Water Conversion

The Office of Saline Water of the U. S. Department of the Interior, and the National Academy of Sciences — National Research Council have planned an International Symposium on Saline Water Conversion for November, 1957.

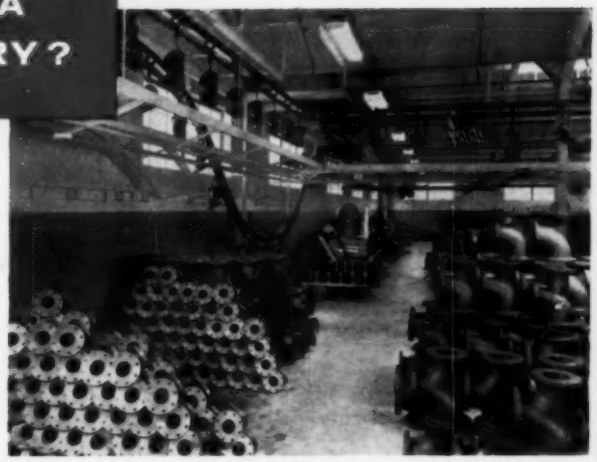
The program for the meetings, which will be convened in Washington, D. C., has been developed by a committee of six scientists and engineers. It covers such topics as power distillation, electrodialysis, osmosis, solar distillation, freezing, and other scientific approaches to the problem of conversion of saline water for agriculture, municipal, and industrial uses.

The objectives are to bring together, on an international scale, active workers in these fields, in the interest of reviewing and recording progress and stimulating new approaches to this important aspect of basic and applied science.

Approximately thirty invitational technical papers will be presented by participating scientists and engineers from the United States, the United Kingdom, Europe, Africa, and other areas of the world concerned with these problems. The scientific papers presented during the three-day conference will be published by the Academy-Research Council in its numbered series of scientific and technical monographs.

Inquiries should be addressed to the Division of Physical Sciences, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington 25, D. C.

NEED FITTINGS IN A HURRY?



You Get Complete Selection and Fast Delivery from Kuhns!

This partial view of our warehouse gives you an idea of the stock we maintain in order to meet your most urgent needs for pipe fittings of any type.

Kuhns cast iron or ductile iron fittings are available coated with a special rust proofing compound, galvanized, or coated to meet your local specifications. Over 3000 sizes and shapes.

Sizes Available

Flanged fittings, all types in sizes from 1½" through 12". Companion flanges; from 1" through 12". Screwed fittings; from ¼" through 12". Every Kuhns fitting is backed with the finest workmanship and strictest quality control that assures you of sharp threads, chamfered edges and perfect sealing. "K" fittings need no "babying"—they'll save time and last longer!

Ductile Iron Fittings

Where corrosion resistance and higher strength are required, Kuhns special ductile iron fittings are available in the same sizes as shown above. These D.I. fittings are all listed and pressure rated by the Underwriters' Laboratories, Inc.

Kuhns fittings are available nationally through better wholesalers.

K

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1800 McCALL STREET • DAYTON, OHIO
1887 • 70 years of Continuous Progress • 1957

W&SW

New Equipment

New Filter Media

1001

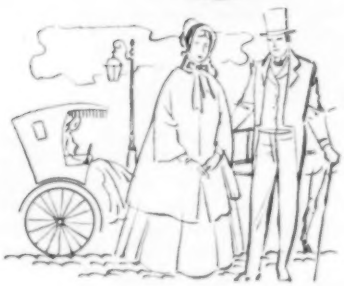
Robert Enterprises, Washington, D. C., has introduced a different form of carbon filter media called "Carbon Wool."

Carbon Wool, is a dense, fibrous form of pure carbon which has a sleek, glossy black appearance. Except for its color it resembles steel wool or glass wool. It is supplied in either an activated form or inert. The fiber diameters presently available range between 1 and 50 microns; fiber lengths are variable. Carbon Wool can be furnished in bulk or in the form of woven cloth.

Some of the advantages claimed for the wool are: when used as a filtering medium, it is non-clogging and has a relatively low pressure drop; it is unaffected in physical appearance by severe, prolonged vibration; can be woven into cloth; has substantial tensile strength; greater uniformity; relatively non-inflammable; and its adsorption and filtering properties equal or exceed those of active granular charcoal.

WATER CONVEYANCE ...is a modern art

M-H



Water always has been vitally important to Man. Ancient camps and cities always were located near water. Yet, conveyance of large quantities of water by pipe lines, pumps and valves for domestic consumption, industrial supply and fire protection, is comparatively a modern art. Only 100 years ago in this country, crude pipes and valves made of bored logs were in common use.

Compare the wooden valve body with its crude iron-paddle gate used in Mobile, Alabama, 1840-1850, with the modern M&H mechanical joint valve above. M & H valves and hydrants today are engineered products, made to conform to exacting standard specifications. That's why leading water works engineers today use M & H valves and hydrants.

For complete information, address

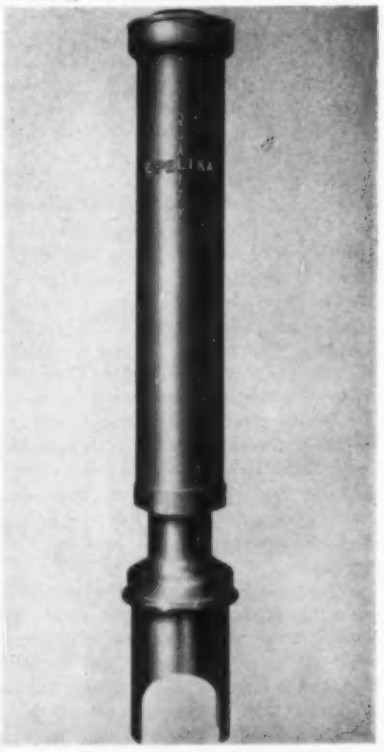
M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF WALWORTH

Insulated Curb Box

1002

Opelika Foundry Co., Opelika, Ala., has designed a cast iron service or curb box with the bell end cock housing made of butyrate plastic.



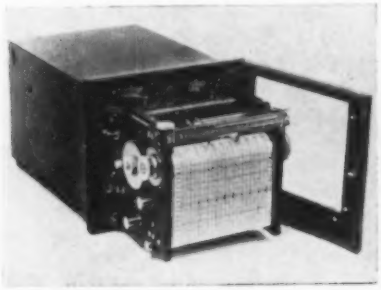
The plastic housing being non-metallic and inert by nature, completely insulates the curb cock and pipe line from the cast iron box, thus eliminating galvanic or electrolytic corrosion.

Where Buffalo type curb boxes are now in use, the parts of the new "Opelika" box will interchange, making additional inventory unnecessary except for the bottom sections.

2 Pen Miniature Recording Potentiometer

1003

Westronics, Inc., Ft. Worth, Texas, has developed a new recording potentiometer that features 2 pens, both writing margin to margin on a single 5-inch strip chart, producing two continuous records in a smaller space than that previously required for two 3-inch recorders and with better accuracy.



The recorder is available with one front set limit switch and 3 back set limit switches on each pen. The amplifiers are completely transistorized, requiring less volume and maintenance than ordinary vacuum tube amplifiers.

The instrument features such specifications as 0.5 percent accuracy on each pen, sensitivity 0.14 percent of scale span, maximum source impedance of 1000 ohm per MV of span, MV or TC calibration case extends only 13 inches behind the panel face.

Optional features include transmitting slidewires, quick change or manual change gears for 3 speed chart drive, selsyn motor or synchronous motor chart drive, automatic reference junction compensation, table or panel mounting and margin marker pens.

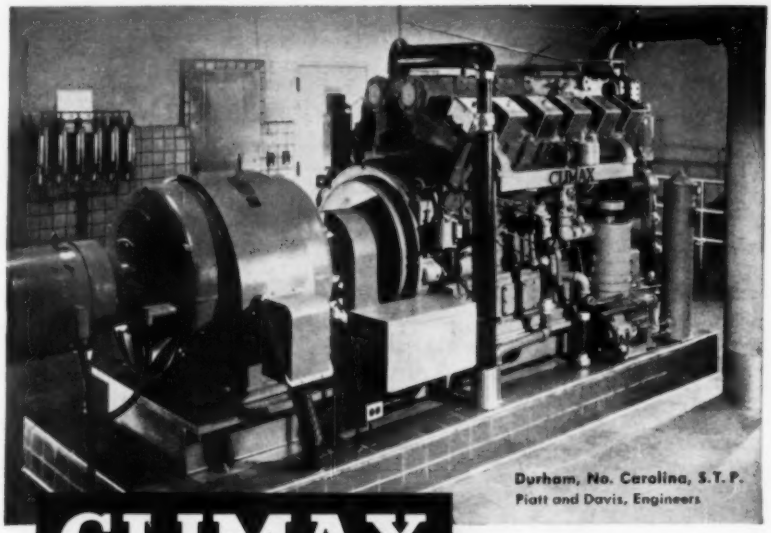
New Filter Aids

1004

Johns-Manville Corporation, New York, N. Y., has started marketing "Fibra-Flo", a line of filter aids that assure filtration flexibility, greater efficiency and lower cost of operation.

"Fibra-Flo", a combination of asbestos and diatomite, developed in the J-M Research at Manville, New Jersey, was first marketed in the brewing industry. Its filtration properties, which are particularly advantageous during the final polishing process in brewing, brought immediate and widespread use.

J-M's Celite Division, in marketing "Fibra-Flo," reports that 110 different combinations have already developed to serve increasing and varied needs.



Durham, No. Carolina, S.T.P.
Platt and Davis, Engineers

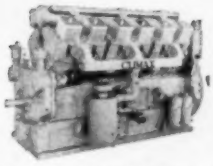
CLIMAX

POWER

FOR SEWAGE TREATMENT PLANTS...

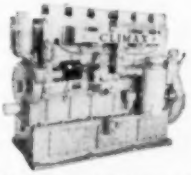
Climax engines can be found on the job every day of the year in hundreds of sewage treatment plants from coast to coast—powering sewage pumps, blowers and generators. Tremendous savings are being realized by using readily available **sludge gas** for fuel and also by utilizing heat from the jacket water and exhaust gas of the engines to heat digesters and buildings. When a shortage of sludge gas is encountered these engines operate on an auxiliary fuel—either gasoline, butane or natural gas, or a combination thereof. Eight Climax engines are available for continuous duty service in Sewage Plants in a range of sizes from 40 to 300 hp.—for standby service up to 605 hp. max. rating.

Write today for complete information, bulletins or engineering consultation.

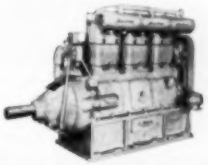


V-125—12 cylinder, 605 max. H.P. at 1200 R.P.M.
V-122—12 cylinder, 520 max. H.P. at 1200 R.P.M.

V-85—8 cylinder, 390 max. H.P. at 1200 R.P.M.
V-80—8 cylinder, 340 max. H.P. at 1200 R.P.M.



K-75—6 cylinder, 302 max. H.P. at 1200 R.P.M.
K-67—6 cylinder, 265 max. H.P. at 1200 R.P.M.



R-165—6 cylinder, 192 max. H.P. at 1200 R.P.M.
R-110—4 cylinder, 130 max. H.P. at 1200 R.P.M.

CLIMAX ENGINE MANUFACTURING CO.
208 South LaSalle Street • Chicago 4, Illinois
Factory—CLINTON, IA. • *District Office*—DALLAS, TEX.

High Rate Composting Machines For Garbage And Refuse Disposal

1005

Eastern Depuration Works, Inc., has available the Depurater, a specially constructed machine for high rate composting that may be the answer to refuse disposal problems where other methods have proved impractical or uneconomical.

A recent field test, the Depurater, a multiple-stage composter, demonstrated its ability to handle the typical mixture of municipal refuse and garbage as it arrived at a city incinerator. Operating time of the Depurater was eight to nine hours daily; shut down at night.

The advantages of this process are: No fly ash, building or operational costs, as in incineration. No open fires, wind-blown trash or smoke, machinery and maintenance costs, rodents, gulls, etc., as in land fill or dumps.

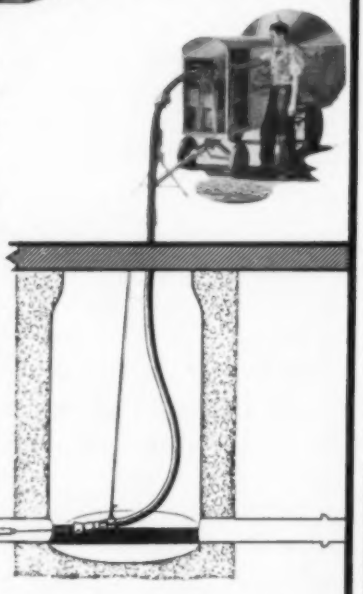
In the test it was found that the composting resulted in the transformation of material which had a grayish color and a sour, greasy odor, typical of raw garbage; to a material dark in color with a slight earthy or moldy odor. The process also resulted in a very high reduction of coliform-type bacteria and a B.O.D. reduction of the leachings from the finished material was about ⅓ of that of the leachings from the raw.

It's FLEXICROME
FOR HIGH SPEED
SEWER RODDING!

25 years ago "**Flexible**" Steel Sewer Rods took the men out of the sewers. When power turning was introduced, **FLEXICROME STEEL** had to be developed to withstand the added stresses and strains

FLEXICROME is the only alloy steel produced exclusively for sewer rodding. There is no known equal, as confirmed by independent laboratory reports. As an added "life preserver," a heat fused, pore sealing coating is applied to improve sewer acid resistance. **FLEXICROME GRoovED COUPLINGS** are also specially designed to **last longer** and couple and uncouple in half the time.

That's why some cities report up to 200,000 feet of sewer rodding with **FLEXICROMES** before replacement.



FLEXIBLE INC.

1005 SPENCERVILLE ROAD, LIMA, OHIO
3786 DURANGO AVE., LOS ANGELES 34, CALIF.
351 W. JEFFERSON BLVD., DALLAS, TEXAS

Rotary Cutter For Large Pipe

1006

Wallace Supplies Mfg. Co., Chicago, Ill., has just designed a machine capable of cutting 20 inch, and larger, pipe-with a cut surface finish suitable for gasket face use.

The machine can handle a 40 ft. (double random length) of 20 inch of larger pipe with wall thickness of ⅞ in. or heavier provided the first cut is 5 ft. or more.

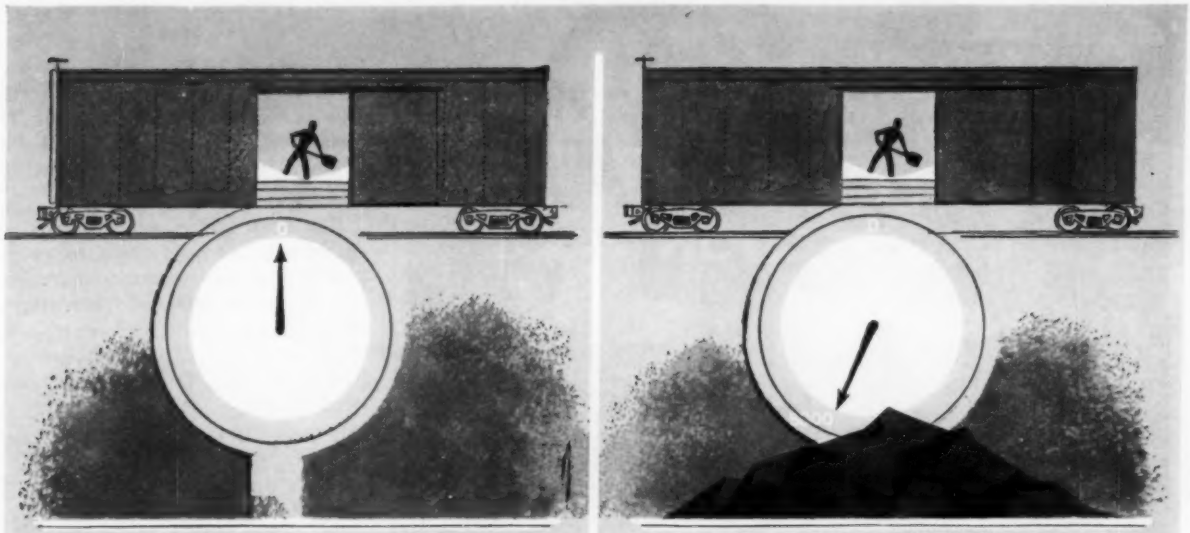
The controls to move the chucking drive up and down for centering is hydraulic, as is the locking system which holds the chuck in proper length position. Movement of the chucking back and forth to control length of cut piece, is electrical as are the rotation and cutting units.

Dual-Channel Telemetering

1007

Moore Associates, Redwood City, Calif., has designed a telemetering transmitter and receiver for telephone lines or cables with up to 20 db attenuation.

These self-contained units, when keyed by switches for control applications or pulse-width signaling transducers for metering, provide two independent signaling tones in the frequency range 2.8 to 100 kc. The frequency is precisely controlled by interchangeable plug-in networks for each channel. The receiver provides two independent regulated outputs up to 20 and 50 amp for recording transmitted data, or by means of plug-in hermetically sealed DPDT relays, up to 20 amp at 250 v for on-off apparatus control over each channel. The plug-in relays can control up to 1-hp motors without the need for auxiliary contactors.

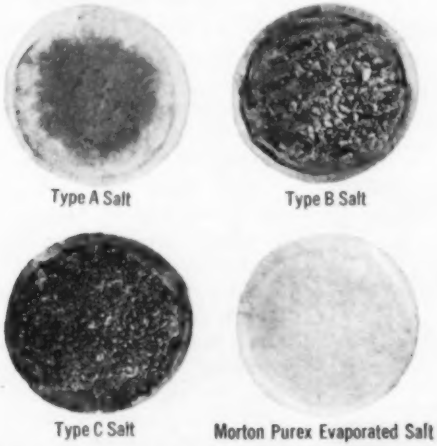


A carload (50 Tons)—of Morton Purex Salt contains virtually no wasteful insoluble matter or sludge—shale and sulphates.

A carload (50 Tons)—of salt can often contain as much as 5000 lbs. of sludge which you pay as part of purchase and freight costs.

Stop paying for wasteful sludge —switch to Purex Salt

These filter pads (approximately 1/5 actual size) show you how much insoluble matter (sludge) you get in just 5 lbs. of various kinds of salt.



Type A Salt — Type B Salt — Type C Salt — Morton Purex Evaporated Salt

Tests for insolubles taken from random samples show you that Morton Purex is the only one that contains no wasteful sludge or insolubles.

For more information about Morton Purex Salt, and for free, expert help on any water-softening problem, write:

When you buy Morton Purex Salt, you get high purity evaporated salt that is made in a controlled-particle size to prevent packing and channeling. With Purex, none of your purchase price or freight bill goes toward paying for useless, troublesome insoluble matter.

With Morton Purex, no time or labor is wasted in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex will leave no accumulation of material in either brine or water softener tanks. It can be used in wet-storage systems, and in the Morton Model-E Brinemaker.

MORTON SALT COMPANY

INDUSTRIAL DIVISION

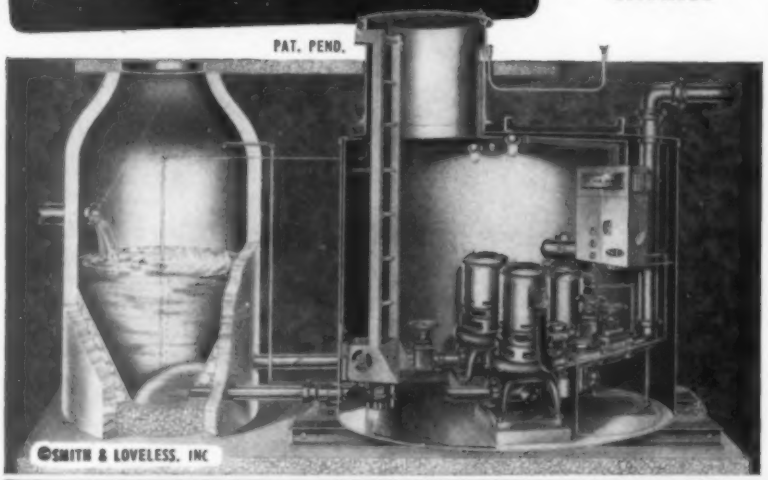
Dept. W10, 120 So. LaSalle Street

Chicago 3, Illinois

HUNDREDS OF INSTALLATIONS—IN 27 STATES!

Specify—
The Smith & Loveless
FACTORY-BUILT PUMPING STATION

PROVEN QUALITY—
WITH FACTORY-BUILT SAVINGS



THE MOST ADVANCED DESIGN IN SEWAGE PUMPING STATIONS

We specialize in building America's finest sewage lift stations. Acceptance proves their quality. Smith & Loveless offer you a complete line of six standard size lift stations with capacities from 20 GPM to 1600 GPM per pump or ejector. Larger capacity stations are built to your order.

- An integrated design, each piece proven by the test of time.
- Precision assembled by factory experts.
- Automatic dehumidifier to eliminate condensation.
- A central electrical control cabinet prewired and color coded.
- Shot blasted steel structure epoxy coated plus cathodic protection.
- Factory tested and adjusted by actual operation before shipment.
- Easily and quickly installed.
- Especially designed for minimum maintenance.

For Job Recommendations, complete specifications, and drawings — all part of the latest edition of the 100 page Smith & Loveless lift station Data Manual . . .

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PLANT: MERRIAM, KANSAS

REPRESENTATIVES IN PRINCIPAL CITIES

Metal Pretreatment Coating

1008

Guardian Chemical Products, Inc., Houston, Texas is now offering Bindox, a pretreatment coating for metal surfaces which can be used on anything from a delicate wrist watch to a battleship.

The basic ingredient for this new product is rice oil, which has penetrating and adhering qualities and contains a natural wax and other properties highly resistant to corrosive action.

Bindox has a high flash point (450°) which makes it particularly adaptable for pretreating hot castings, and after thorough drying the film remains stable up to 600°.

Bindox may be applied by brush, spray, roller, or dipping.

Heavy duty Rust-X is used for exposed metal surfaces such as outdoor machinery and equipment, metal buildings, ship's bulkheads, etc.

Unlike many other pretreatment coatings, Bindox has a very mild, slight paint-like odor, and does not deteriorate in its container. It is available in clear form with a light amber hue, with pigmented Rust-X also available in industrial red and gray.

Plastic Pipe For Drains and Sewers

1009

Yardley Plastics Co., Columbus, Ohio, is now marketing C/D rigid plastic for drains and sewers, following intensive independent laboratory tests to prove its performance.

Made of high-impact Styrene base material, it comes in 10 and 20 foot sections, easily joined without special tools by the use of fittings that are solvent-welded to the pipe.

After rigid testing of the pipe in one of the nation's largest cities, the company states that the city sanitary engineering department authorized Yardley C/D rigid plastic pipe for: footing drains for residential construction; building sewer installations for dwellings of four families or less; field drainage lines; special wastes (industrial processing liquid wastes); underground storm drainage pipe; and installations in excavations up to 10 ft. deep.

The pipe comes in various sizes from ½ to 6 inches.

Pipe and Bolt Machine

1010

Beaver Pipe Tools, Inc., Warren, Ohio, has announced the new Beaver S-4 Speed-O-Matic Pipe and Bolt Machine that features a new Universal-type die head which has three sets of high-speed steel dies and threads from ½ to 2 in.

The new machine uses one universal die head and three sets of duo-type dies (½ x ¾ in.) (1 x 1¼ in.) and (1½ x 2 in.). Both duo-type and mono-type die heads are available with machine.

The S-4 Speed-O-Matic is claimed by the manufacturer to be the very latest in portable pipe and bolt machines. It's light, fast, powerful, and the cutoff dieheads and reamer are all pivot mounted and swing out of the way when not needed. A special oiling tube directs cutting oil right to the threading dies. Oil shuts off automatically when tube is moved out of position.

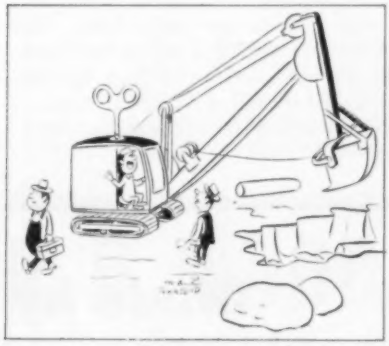
Special Tools For Threading and Holding Brass Tubing

1011

J. A. Sexauer Manufacturing Co., New York, N. Y., has developed a tool specially made to thread 3 sizes of brass tubing, and a holder that insures a proper grip on the tubing being threaded.

The Sexauer 3-in-1 tube threading tool has 3 dies that cut a 27 thread per inch on 1, 1¼, and 1½ in. brass tubing. The tool's 1 and 1¼ in. dies have 6 cutting lands; the 1½ in. die has 8 cutting lands.

The companion unit, the 5-in-1 tubing holder, grips ¼, 5/16, 1, 1¼, and 1½ in. tubing in a rigid position for either threading cutting or glaring. It consists of 2 parts which are locked together by wing nuts and, when clamped in the jaws of a vise, holds the tubing firmly without damaging or distorting it.



"Yep! I got the idea from my kid's shovel. Now, we're all fixed if we can't get gas."

DURAJOINT PVC WATERSTOPS

TESTED . . . and proven BEST!

Test after test, made by various independent research organizations, conclusively prove that DURAJOINT Waterstops are the only waterstops available on which you can stake the safety of your design and reputation. The results of these tests plus the many other advantages offered by DURAJOINT Waterstops are concisely stated in our new Waterstop Manual No. 457. Check and mail the coupon below for your free copy . . . it will make an excellent addition to your waterstop file.

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☐ Please send me, without obligation, a copy of Manual No. 457.

☐ Have Representative call.

NAME_____

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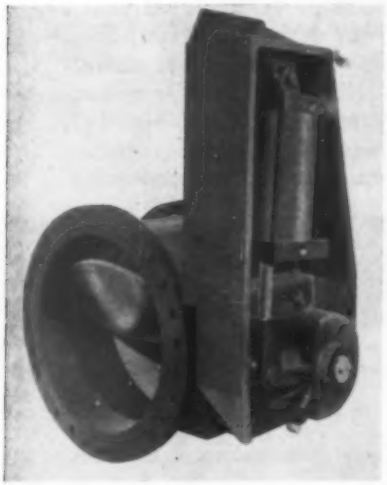
Portable Hydrostatic Tester
1012

Farris Engineering Corp., Palisades Park, N. J., has developed a "Porta-Tester," weighing only 55 lbs., for general use in at-the-site hydrostatic testing of valves, pressure vessels, piping, steam generators, pump cases and other equipment at pressures up to 3000 psi.

The completely portable unit is only 18 x 14 x 8 in. and can be carried like an overnight case. It is complete with four test-accuracy gauges and eight feet of hydraulic, flexible tubing that packages on the rear of the cover for portability. The pump handle folds flat for easy storage in the case. The unit can be used with water or other hydraulic fluids.

Rubber Seated Butterfly Valves
1013

S. P. Kinney Engineers, Inc., Carnegie, Pa., has available a line of rubber seated butterfly valves for applications where an absolute water tight shut-off is required, under pressure up to 125 lbs. psi. Sizes range from 6 to 96 inches, or larger.



The Kinney valve is equipped with a resilient removable rubber seat of synthetic or natural rubber, vulcanized around a continuous steel ring insert. The seat is held in place in the center section of the valve body by a single piece keeper ring. The steel ring insert serves to increase the firmness of the seat, resulting in greater wearability and long life. The ring also gives the seat rigidity for quick and easy installation or replacement, plus enabling the seat to always remain concentric to the valve body. Two shaft holes in the seat are smaller than the diameter of the shaft, creating a hugging effect and assuring a positive leak-proof condition at these two points.

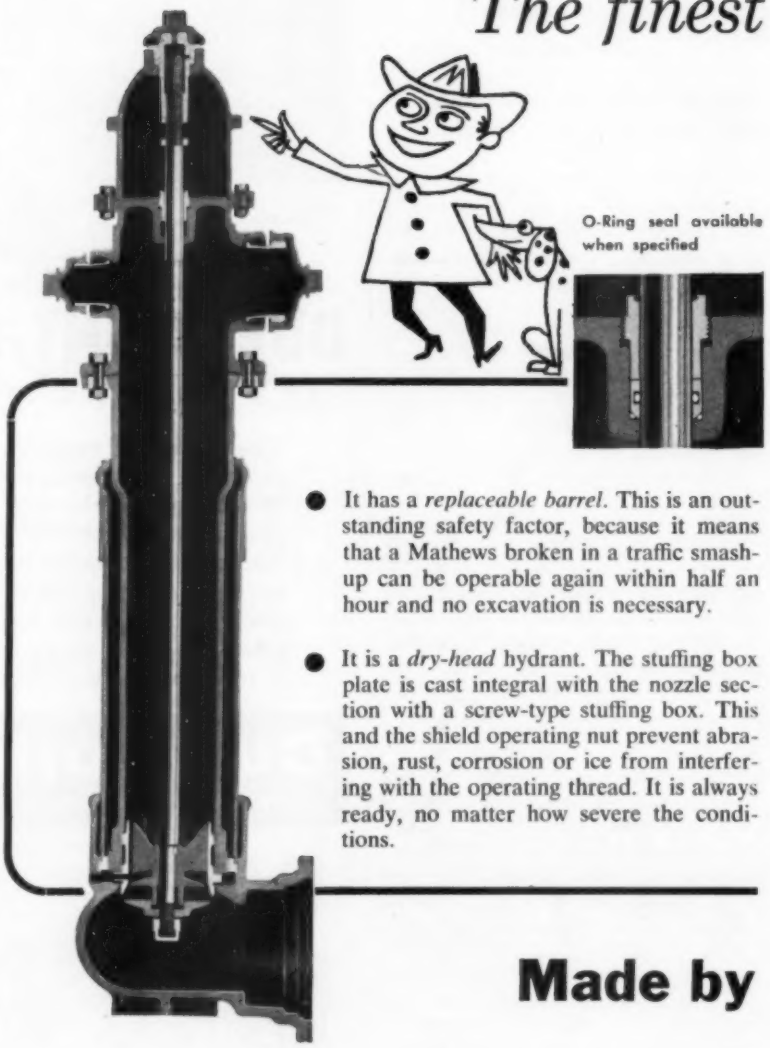
Water Plant Dosage Automation
1014

Wallace & Tiernan, Inc., Belleville, N. J., has introduced the W & T Quality-Quantity chlorinator that automatically adjusts the chlorinator feed rate to compensate for changes in chlorine demand of the water being treated, and at the same time proportions chlorine feed to the flow of water.

This system utilizes the V-notch variable orifice for accurate and wide range chlorine feed, and consists of five major components: the chlorinator; dosage controller; pressure reducing valve; hydraulic-electric differential controller; and an injector.

MATHEWS

The finest



- It has a *replaceable barrel*. This is an outstanding safety factor, because it means that a Mathews broken in a traffic smash-up can be operable again within half an hour and no excavation is necessary.
- It is a *dry-head* hydrant. The stuffing box plate is cast integral with the nozzle section with a screw-type stuffing box. This and the shield operating nut prevent abrasion, rust, corrosion or ice from interfering with the operating thread. It is always ready, no matter how severe the conditions.

Made by

Plastic Pipe Carries Corrosive Chemicals For Water Plant

1015

U. S. Rubber Co., Naugatuck Div., New York, N. Y., has announced that the company's Kralastic pipe has been used successfully for the past two years to carry corrosive chemicals in the 1-MGD Elm Fork Water Purification Plant in Dallas, Texas.

Chlorine, ferric sulphate, aluminum sulphate and slaked lime are being carried under low pressure in the plastic lines. Lead-lined steel and stainless pipe were formerly used to carry these chemicals, but plastic proved less costly and easier to install than the metal pipe.

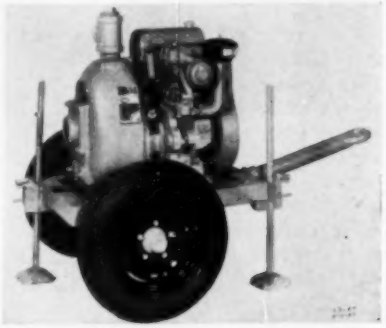
The pipe in use is mainly four inches in diameter. It was installed in 20-ft. lengths, using sleeve-type fittings that were cemented in place.

After two years use there is no sign of corrosion in any of the plastic line, report officials of the water department.

New Pump Mounting

1016

Rice Pump & Machine Company, Belgium, Wisconsin now offers a 3-in.-20M Pump with new heavy duty trailer count. Automotive type jacks have been adapted for steadying stands to permit exact leveling. The Timken taper roller bearing wheels are



equipped with standard 5:90 x 15 in. implement tires to assure ease in handling on rough ground. Towing tongue telescopes when not in use. This mounting with large towing ring tows easily and may be pulled by a truck and need not be hoisted up into a truck for moving from job to job. Rice offers this mounting on 20M, 30M, 40M and 90M sizes (3 in. thru 6 in).

All-Plastic Check Valve

1017

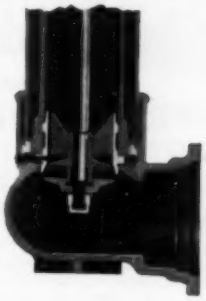
The Walworth Company, New York, N. Y. has introduced an all-plastic lift check valve. Body and components of the new valve are made of normal impact rigid polyvinyl chloride to provide high corrosive resistance to alkalis, acids, inorganic salt solutions and other corrosive flow material. A highly durable PVC spring positions the disc to assure quick and complete shutoff.

The new PVC check valve operates successfully at pressures up to 150 psi at 75°F. Complete shut-off was obtained with the valve during and after 2 million continuous cycles under 125 lbs. of air and 50 lbs. of water.

HYDRANTS...

community protection by design

If you sat down and checked off the features that a well-designed hydrant ought to possess, you would find yourself describing a Mathews Modernized Hydrant



- The main compression-type valve opens *against* water pressure. The higher the pressure, the tighter the valve—a positively leakproof construction.
- **OTHER QUALITY FEATURES**

The operating thread cannot be bent. Head revolves 360°. Nozzle sections can easily be changed. Nozzle level can be raised or lowered without excavation. Bell, mechanical-joint or flange-type pipe connections.

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Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe (centrifugally cast in sand molds)

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BLACKBURN-SMITH SEWAGE EJECTORS

These time-tested pneumatic sewage ejectors do away with complex piping . . . screens, impellers, shredders and pumps that need constant cleaning . . . in short, give you BETTER sewage ejectors for less money. It will pay you to know about their many exclusive features of design and control and operation. Write today for Bulletin S-55.

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Also made in single units

30 to 500 gpm 150-ft. head

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It includes piping diagrams for electrode and float switch controls, plus dimensions and layouts. A book that modern municipal engineers will find mighty interesting and helpful. Your copy's ready.

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"One Man" Field Tool Machines any A-C Profile

model B
SPRING LOAD A-C MACHINING AND TAPERING TOOL

Cuts lathe-smooth joints with machine shop precision *faster, and right on the job,* for:

- RING-TITE COUPLINGS
- SIMPLEX COUPLINGS
- ROTO-SPLIT FLANGES
- POURED FLANGE ASSEMBLY
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- MAKING CLOSURES
- END FACING

Save on installation time, salvage broken and short pieces, eliminate machine shop, lathe, and hauling costs! This one-man tool accurately machines closures up to 9" couplings, on the job! Approved by leading A-C pipe manufacturers. Ask for it, and Spring Load A-C Pipe Cutters at your suppliers, or write.

Sizes for 4"-8" and 10"-20" pipe. For holding 4"-20" A-C pipe, use Spring Load V-20 vise.

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W&SW MANUFACTURERS NEWS

Byers Co. Promotes Kelly

A. M. Byers, Company, Pittsburgh, Pa., has announced the appointment of William J. Kelly as manager of the firm's Washington, D. C., division.

A graduate of Grove City College, Mr. Kelly has been with the Byers Company since 1939. He has worked out of the company's Washington, D. C., office for the past twelve years.

Prior to joining the Byers Company, Mr. Kelly was with Metals & Alloys, Inc., and Grove City Brass & Bronz Company. He is a member of the American Road Builders Association, Lions and Kiwanis.

Kennedy Appoints Four In Sales Dept.

Kennedy Valve Mfg. Co., Elmira, N. Y., has announced four new appointments to the Sales Dept.

Gene Reinersman will headquarter in Covington, Ky., and southern Indiana. Reinersman was previously with Amstan Supply, Div. of American Radiator and Standard Sanitary Corp. as an industrial salesman, Cincinnati metropolitan area and prior to this covered Ohio, Kentucky and Indiana for the George F. Carr Co. as manufacturer's representative.

W. F. Strickland, a University of Georgia graduate, will have his quarters in Decatur, Georgia. He was previously salesmanager of Wilson and Minkin of Atlanta, Georgia, and will work in that area.

A. E. Hockaday will work out of Dallas, Texas. A graduate of Southern Methodist University, Hockaday has had sales experience with Conner Supply Co. and Metal Goods Corp. in Dallas. He now makes his home in Dallas.

Edw. Shortall will headquarter in

San Francisco and is a native of that city. He has been designated representative for northern California. He was formerly with Scott Co., mechanical engineers and contractors in San Francisco and Los Angeles.

Peerless Promotes Lundy

Peerless Pump Div., Food Machinery & Chemical Corp., Los Angeles, Calif., has announced the appointment of Everett W. Lundy as General Sales Manager. He was previously assistant Sales Manager and succeeds B. A. Tucker, Retired.

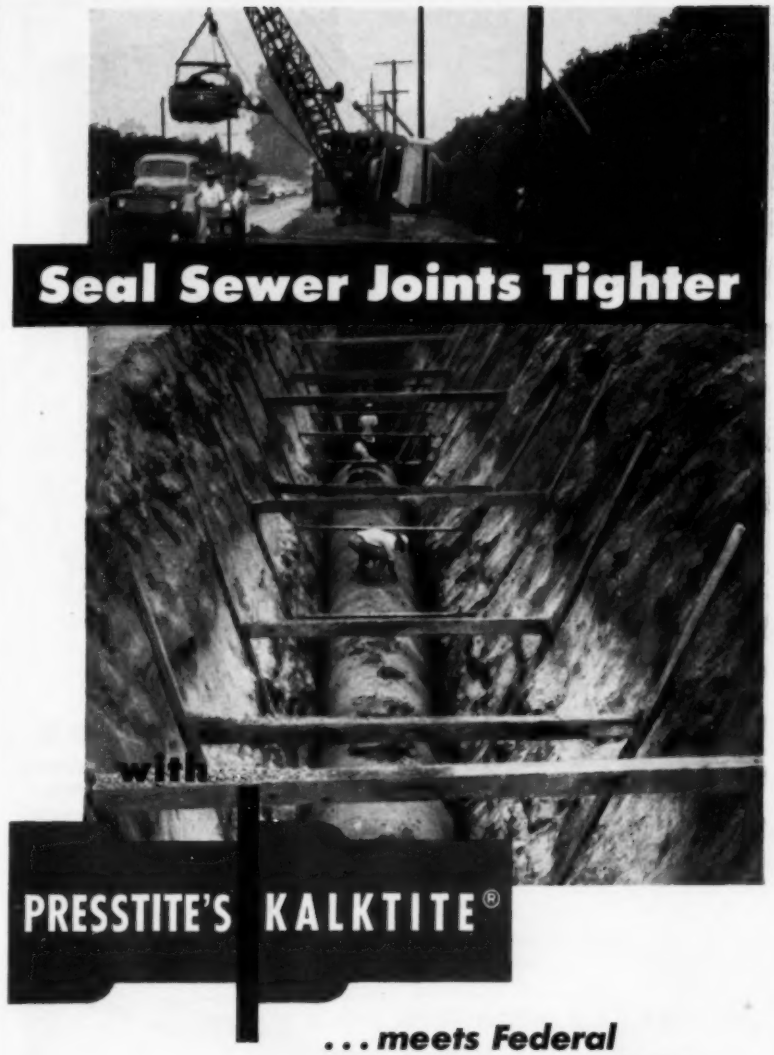
Mr. Lundy attended the University of California at Berkley. Subsequently he became associated with the Sterling Pump Corporation, and joined the Peerless organization in 1940. Successive promotions from sales engineer to branch office manager at Phoenix to Pacific district sales manager is now climaxed with his new appointment.

American Meter Co. Absorbs Philadelphia Pump & Machinery

American Meter Company, Philadelphia, Pa., has announced that, the totally owned subsidiary, Philadelphia Pump and Machinery Company, has been merged into, and become the Philadelphia Pump Division of American Meter Company, with headquarters at 13500 Philmont Avenue, Philadelphia.

Robert J. Browne, graduate mechanical engineer, Mass. Institute of Technology, formerly research engineer, Ford Motor Company, and more recently project engineer of the Pump Division of Eaton Manufacturing Co., will be Chief Engineer and General Manager of the new Philadelphia Pump Division.

Louis G. Alaman, BScC, University of Notre Dame, will continue as Sales Manager. Mr. Alaman came with the Philadelphia Pump Company two years ago following 15 years of sales management experience with Worthington Pump here and abroad.



...meets Federal Specification SS-S-168

Over the past 30 years, the Presstite Sealing System has been thoroughly service-proved by many leading engineers and contractors. They will assure you it's the easiest, most economical way to get strong, tight joints that eliminate practically all ground water infiltration.

PRESSTITE'S 3-STEP SEALING SYSTEM

PRIMER	Improves bond between pipe and sealing compound.
ROPAX®	Non-porous, adhesive packing. Compresses to form additional seal impervious to water.
KALKTITE®	Cold mixed and cold applied. Dense, flexible, asphaltic cement. Sets internally; unaffected by hot, cold, wet or dry conditions.

WRITE for working samples and 20 page catalog.

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PRESSTITE-KEYSTONE ENGINEERING PRODUCTS COMPANY
KAP

A Division of AMERICAN-MARIETTA COMPANY
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with confidence!

WHEN you're specifying — don't start until you have this new Crispin Air Valve Catalog in your hands! Its 28-pages give detailed information on all Crispin service-engineered products that, for over 45 years, have provided safe, precise control of air in pipelines.

This new Crispin Catalog is a 2-color, fully illustrated workbook on the entire line of Crispin Valves. Complete specifications, operating charts and data, and detailed parts lists on the popular and dependable Crispin Air Valves are included. In addition, there's a section on "Special Types of Crispin Valves" and Crispin Slip Joints along with facts on other products made by the Multiplex Manufacturing Company. "How to Order" and "Where to Buy" information completes this useful handbook.

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BERWICK, PENNSYLVANIA
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OVER 45 YEARS

N-SOL (ACTIVATED SILICA)
SOLVES THESE
WATER PROBLEMS . . .

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- SHORT FILTER RUNS

N-Sol (activated silica sol) with your regular coagulant forms large, strong, rapid-settling floc and delivers clear, sparkling water. Evaluate results in your plant.

SAMPLES OF N SILICATE AND DIRECTIONS FOR JAR TESTS ON REQUEST.*

*N-Sol is made in your plant from our N sodium silicate (shipped in drums or tankcars).

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N-SOL PROCESSES
PQ SOLUBLE SILICATES

Gibbon, Page and Parnell Join Worthington-Gamon Sales Staff

The Gamon-Meter Division, Worthington Corporation, Newark, N. J., has announced the addition of R. G. Gibbon, H. R. Page and R. O. Parnell to its sales staff to represent them in the sale of liquid meters in the Western part of the country.

R. G. Gibbon will represent Gamon-Meter in Texas. A resident of Amarillo, Texas, Mr. Gibbon was associated with the Viking Supply Corporation, Lewis Dodson Engineering Co. and the M. B. McKee Company prior to joining Worthington Gamon-Meter Division.

H. R. Page will assist the Gamon-Meter sales staff operating in the states of Colorado, Wyoming, Nebraska and South Dakota. A resident of Englewood, Colorado, Mr. Page was a sales representative with Neptune Meter Company before joining the Worthington Gamon-Meter Division.

Formerly associated with the Richfield Oil Company, Mr. R. O. Parnell will operate in the states of Washington, Oregon and Idaho for Worthington Gamon-Meter Division.

Chicago Bridge Promotes Goldsby and Hamilton

Chicago Bridge & Iron Company, Chicago, Ill., has announced the appointment of Fred L. Goldsby, vice president and formerly general sales manager, as assistant to the president. S. C. Hamilton, formerly district sales manager, Houston, Texas, has been made a vice president and general sales manager with headquarters in Chicago.

Mr. Goldsby, who joined CB&I in 1927 in the Chicago shop, has worked in the operating department; as assistant to the chief engineer; in the research department; and as manager of the company's foreign erection department and export manager in New York. He has been general sales manager and a director since 1954.

Mr. Hamilton, district sales manager in Houston since 1940, and a director of CB&I since 1946, joined the company in 1928 in the engineering department at Chicago. He was transferred to the engineering department of Horton Steel Work Limited, Fort Erie, Canada, in 1929. He later worked in the CB&I erection department, the Birmingham, Ala., shop and sales office, and in 1937 was named district sales manager.

M-H Adds 141 To Industrial Field Forces

Minneapolis-Honeywell Regulator Company's Industrial division, Philadelphia, Pa., has announced the appointment of 141 sales and service engineers to some 90 offices of the Company during the past six months.

The assignment of the new men—71 sales engineers and 70 service engineers—was part of a planned ex pansion program.

The addition of the new men, all graduates of the division's 22-year-old Instrumentation Education Center, Philadelphia, increases the Industrial Division's field force to more than 600 men.

Bailey Meter Promotes Bridgman

Bailey Meter Company, Cleveland, Ohio, has announced that K. T. Bridgman has been named manager of the company's Schenectady district office. Bridgman succeeds J. F. Luhrs who has been assigned to the Cleveland main office.

Mr. Bridgman, formerly resident engineer in Springfield, Mass., joined the company in 1926. A Registered Professional Engineer in the State of Massachusetts, he is a graduate of Purdue University and holds a bachelor of science degree in mechanical engineering.

Fischer & Porter Moves New York Office

Fischer & Porter Company, Hatboro, Pa., has announced that the company's metropolitan New York Sales Office is now located at 141 Main Avenue, Clifton, New Jersey. The office was formerly located at 139 Chestnut Street, Nutley, New Jersey.

A staff of 15 persons will occupy an air-conditioned building recently constructed especially for Fischer & Porter. Donald T. Cusack, divisional manager of the New York area, will head the Clifton office.

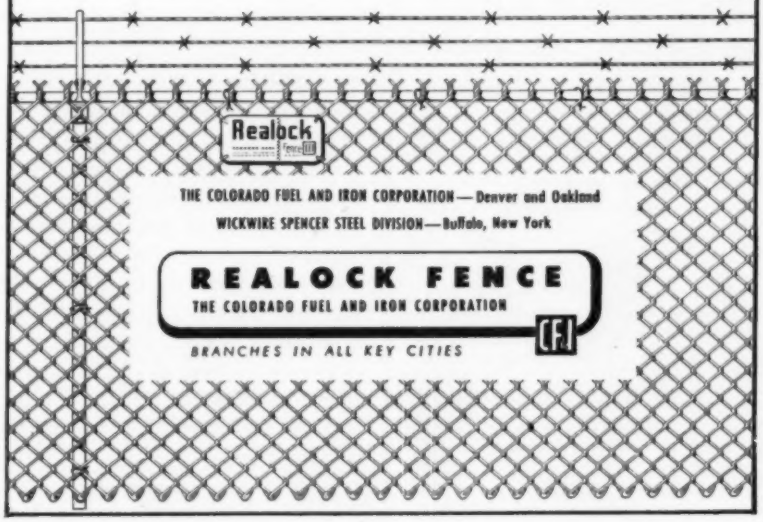
REALOCK FENCE *means*

NO TRESPASSING!

For institutional and industrial plants, Realock Fence and Gates help prevent trespassing, burglary, arson and vandalism—with minimum patrol requirements.

Furnished with barbed or knuckled selvages. Galvanized after weaving for complete corrosion protection. Supplied in several types and all standard heights up to 12'.

2941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THE COLORADO FUEL AND IRON CORPORATION — Denver and Oakland
WICKWIRE SPENCER STEEL DIVISION — Buffalo, New York
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THE COLORADO FUEL AND IRON CORPORATION
CF&I
BRANCHES IN ALL KEY CITIES

Pittsburgh Coke Promotes Two

Pittsburgh Coke & Chemical Co., Pittsburgh, Pa., has promoted two executives to head activities of its expanded Protective Coatings Div.

Norman T. Shideler was elected president of Insul-Mastic, Inc., a newly acquired subsidiary producing for the Protective Coatings Div., while Arthur E. Gray was named to succeed Mr. Shideler as the division's general manager.

Mr. Shideler will also act as technical adviser to the vice president-Chemical Divisions with regard to all industrial protective coatings and tar products of Pittsburgh Coke. He will have direct responsibility, as president of Insul-Mastic, Inc., for all coatings research and development for the new subsidiary.

As general manager — Protective Coatings Div., Mr. Gray will be responsible for management of the division which will now market the gilsonite asphalt mastics in addition to the division's tar base coatings. Mr. Gray was formerly sales manager of the division.

For Municipal Water
FLUORIDATION

You get three-way economy, safety and assurance of ample supplies with

INTERNATIONAL
HYDROFLUOSILICIC
ACID

Municipalities save three ways with *International Hydrofluosilicic Acid:* in cost of equipment installation, in operating cost and in cost of materials. Handling and control of liquid feed is simple and easy with a minimum of space needed for storage.

Liquid feed assures maximum safety for operating personnel.

International Hydrofluosilicic Acid is available for immediate delivery in tank truck and tank car deliveries.

Shipments are currently being made from plants at Mason City, Iowa; Chicago Heights, Illinois; Lockland (Cincinnati), Ohio; Buffalo, New York; East Point, Georgia; Hartsville and Spartanburg, South Carolina and Tupelo, Mississippi. Other shipping locations will soon be available.

With ample raw materials and large production facilities, *International* can provide municipalities with a dependable source of supply today and in the years ahead.

International Hydrofluosilicic Acid runs typically 23% to 25% H_2SiF_6.

If you are fluoridating now or planning to do so soon, it will pay you to talk with *International's* representative about the use, handling and costs of *Hydrofluosilicic Acid*. Please write or phone the office near you.

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
POTASH DIVISION
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485 Lexington Ave., New York 17
Midland, Texas
Fulton National Bank Bldg., Atlanta, Ga.

Steel Tank Co. Moves To New Headquarters

Steel & Tank Service Company, Charlotte, N. C., has announced that the location of its new general offices, warehouse and shop is now 308 Clanton Road, Charlotte, N. C.

According to the company, this move was brought about by the need for additional space to better serve its increasing number of clients.

Neptune Purchases 4-Level Factory Building

Neptune Meter Company, New York, N. Y., has announced the purchase of a four-level, city block square, factory building formerly occupied by the Columbia Broadcasting System.

The building, located on a plot 600′ x 200′ occupies the area from 47th to 48th Avenue and 34th to 35th Street in Long Island City, New York..

The new plant will provide more than 270,000 square feet of interior floor area for manufacturing and operating activities. At present, the firm plans to devote the space to its Liquid Meter Division concentration on the manufacture and assembly of water meters, petroleum and LP-gas meters, industrial liquid meters, and registering and accessory components used with these products. Final plans for the modernization and layout are now being made, and the Company expects to begin moving into the new premises within six months.

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CYLINDRICAL
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SAVE MONEY, TIME, CALL-BACKS!
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ORDER NOW — Wire or call Kirby 1-4200 collect for fastest delivery!
AQUA SURVEY & INSTRUMENT CO.
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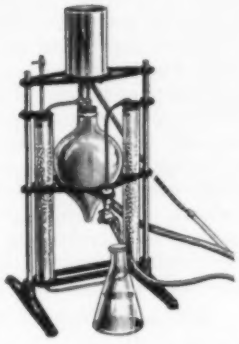
STABILITY INDICATOR



For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

WRITE:

Phipps & Bird, Inc.

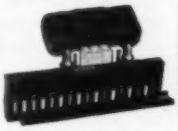
P. O. Box 2V Richmond 5, Va.

TAYLOR COMPARATORS

Help You Maintain Uniform

pH, CHLORINE LEVELS

For Trouble-Free Water System, Sewage Operations



Accurate, on-the-spot colorimetric tests for pH, chlorine made with Taylor Comparators give you dependable operational data in minutes . . . help you control coagulation, chlorination, algae in water treatment, digestion and foaming in sewage plants. Determinations are made in three easy steps. Complete instructions, all necessary accessories and reagents included in every set. Fluoride sets also available.

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Be sure to use only Taylor reagents and accessories with Taylor Comparators to assure accurate results. All Taylor liquid color standards carry an unlimited guarantee against fading.

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W&SW New Literature

Recorders, Indicators And Controllers

1018

Hagan Chemicals & Controls, Inc., Pittsburgh, Pa., has just published a bulletin on the company's newly designed line of **Ring Balance Recorders, Indicators and Controllers.**

The bulletin uses arrow and caption treatment to explain the many proprietary features incorporated in the instruments which have built their reputation for precise measurement and control of process variables. Also of help to engineers, is a full-page table of applications to show some of the many situations in which the Ring Balance pinciple gives outstanding performance.

Motor Starters & Contactors

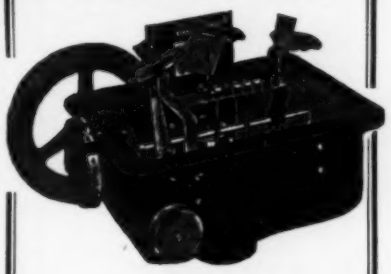
1019

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has just released a 12-page bulletin on its complete line of **Motor Starters and Contactors** in sizes 4, 5, and 6, 50 to 400 hp.

According to the bulletin these starters and contactors have been designed to assure full rated capacity, maximum motor protection, longer life and easy maintenance. The contactors incorporate ACBO arc centering blowout, a modern principle of arc interruption which eliminates the need for conventional blowout coils. In further explaining the device, the bulletin states that it uses thermal convection and magnetic action to center, rupture and quench the arc quickly and effectively.

Write Today For 108 Page Catalog
W. S. DARLEY & CO., Chicago 12

ROTO-TROL



RF-2

WITH ALTO-TROL

This 2-pump RF-2 Roto-Trol assures equal use and wear of both pumps. Each pump is operated on alternate starting cycles.

The RF-2 operates both pumps together, when required. RF-2 installations give dependable service year after year, with the minimum of attention.

Write for full data

WATER LEVEL CONTROLS DIVISION

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The Heart of fine WATER PURIFICATION

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SYSTEMS

Roberts Mechanical Equipment

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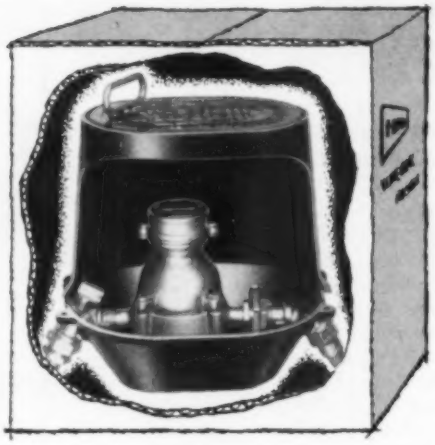

For Meter Settings In Warm Climates or Shallow Services the Yokebox Is a Real "Package Deal" Bargain.

The Yokebox Includes Valve and Couplings and Is Easily Installed As a Unit. It Provides Complete Protection, Even From Mud, Dirt and Pests From Below. Meter Remains Clean and Easy To Read. Meter Changes Are Quick and Trouble-Free.

Easy to handle, quickly installed.

Meter changes quickly and easily without special tools.

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Over 35 Years Of Dependable Performance

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General offices and works W. Medford Sta., Boston, Mass.

Automatic Valves
1020

A. W. Cash Valve Manufacturing Corp., Decatur, Ill., has available a 12-page condensed catalog featuring their complete line of **Automatic Valves.**

The catalog covers main uses, installation tips and construction features along with specification tables for each principal series of Cash Acme valves. Cut-away illustrations give the reader an idea of how each type of valve is designed.

Among the various valves covered are pressure-temperature relief valves for water; special purpose relief valves; industrial type pressure reducing and regulating valves for steam, water, air or oil; and boiler pressure controls and valves.

Relay Test Instruments
1021

Multi-Amp Corporation, Union, N. J., has just released a data sheet that describes a new line of **Relay Test Instruments.**

This 5-page descriptive brochure gives complete specifications, block diagrams and photographs of the new Multi-Amp line of relay test instruments. It includes a selector chart that enables a relay test man to determine at a glance the particular model most applicable to his needs.

According to the brochure, this new line of instruments consists of five models. Each model is tailored to suit the user's requirements, depending on the various types of protective relays employed. These instruments are portable, compact and enable the user to save approximately 75 per cent of the set-up time usually required for the testing of relays.

Polyethylene Ware For Laboratories
1022

Fisher Scientific Company, Pittsburgh, Pa., has just published an 8-page bulletin on **Fisher Polyethylene Ware.**

Featured in the bulletin are beakers with a softening-point above 250°F; 13-gallon polyethylene aspirator bottles with all-polyethylene spigots; translucent tubing that contains no plasticizers, retains flexibility even on aging; a high-safety pipet-filler that cannot spill even when knocked over; and just above everything from one-ounce vials to giant carboys approved by the Interstate Commerce Commission.

Low Temperature Pipe Covering

1023

Glo-Brite Products, Inc., Chicago, Illinois, has just released a complete new size, price and technical data brochure on **Styrofoam Low Temperature Pipe Covering.**

Sizes, prices and a comprehensive guide in ordering are given in this brochure for anti-sweat, light, standard and heavy duty wall thicknesses pipe covering, as well as fitted covers and vessel-tank insulation. A special list gives sizes and prices for domestic pipe size coverings to combat condensation problems on cold water pipes in the home.

Motor Control Centers

1024

Cutler-Hammer, Inc., Milwaukee, Wis., has just published a bulletin describing the **Cutler-Hammer Unitrol,** the standardized motor control center.

This 32-page bulletin features Unitrol's new concept of modular design, which presents a wide variety of motor control in a central structure.

Copiously illustrated with photographs, charts and layout plans, it presents the varied application and engineering data for facilitated selection and planning.

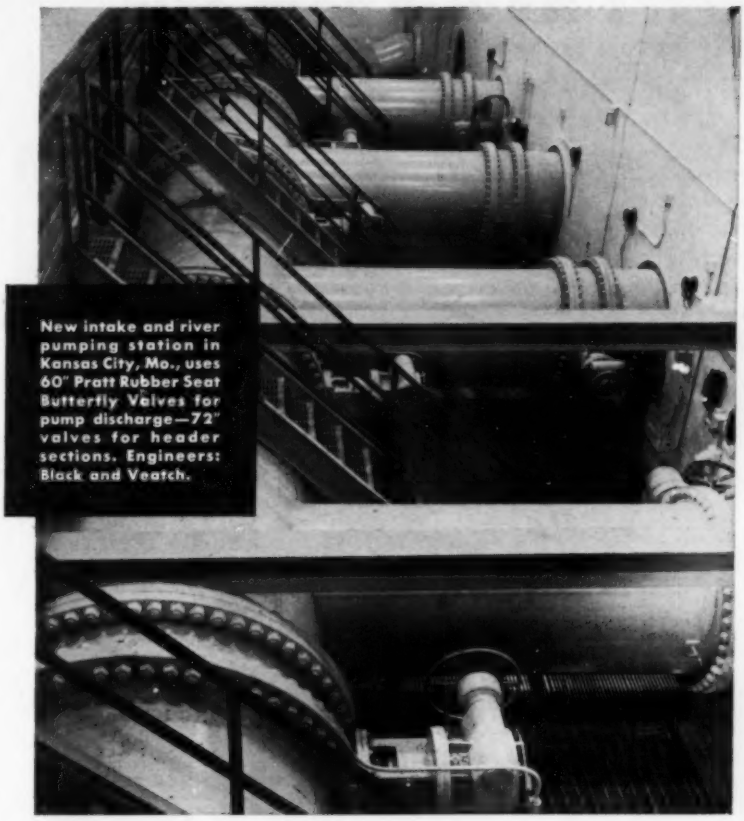
Water Analysis With The MF Millipore Filter

1025

Millipore Filter Corporation, Watertown, Mass., has available, on a loan basis, 53 full color transparencies in either 35mm of 2¼ x 2¼ in. size for screen projection. A complete descriptive text for approximately a 1 hour lecture accompanies the slides.

This illustrated training course is designed to teach the basic techniques and use of the Millipore Filter for the bacteriological and biological analysis of water. Both laboratory and field analytical techniques are presented.

The material covers a description of the Millipore Filter and its basic characteristics; illustrates the apparatus and materials required and fully describes the preparation, filtration, cultivation and evaluation techniques involved in water analysis for coliform bacteria. Plankton and algae analysis techniques are also illustrated and described. Other indicated applications of the filter in other fields are briefly treated.



New intake and river pumping station in Kansas City, Mo., uses 60" Pratt Rubber Seat Butterfly Valves for pump discharge—72" valves for header sections. Engineers: Black and Veatch.

KANSAS CITY:

Rugged efficiency in a minimum space

Look! A modern pumping station with compact, unobtrusive large-diameter valves that require no more clearance than a standard pipe flange, and operators that are equally compact. Face-to-face dimensions of these 60" and 72" diameter Henry Pratt Rubber Seat Butterfly Valves are only 15" and 18" respectively.

Specifying Prat. valves means important savings in space and installation costs—but even more important, economy through years of efficient maintenance-free operation.

Pratt originated the Rubber Seat Butterfly Valve and has installed more of them than any other manufacturer.

For valve design with a 50 year reputation for practical imagination, see Henry Pratt.

NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.

Write for Manual B-2B.

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Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities.

It's *New Again* with THORITE and THOROSEAL

Freeze-thaw cycle following water and moisture penetration, also swelling of reinforcing rods from moisture contact, cause masonry destruction.

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Workmen on scaffold patch spalled and cracked concrete with THORITE and seal surface with THOROSEAL.

Area at left chipped to sound masonry. It will then be patched with THORITE *Nonshrink, Nonslump 20-Minute Set Patching Mortar*, without necessity of costly forming, finished by application of Thoroseal.

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Write for our 16 page "How to Do It"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA • CENTERVILLE, INDIANA

Hi-Cone System For Activated Sludge Processes

1026

Yeomans Brothers Co., Melrose Park, Ill., has just released a 12-page catalog on the **Hi-Cone System** for treating sewage and industrial wastes by the activated sludge process.

Two full pages tell, in detail, how the Hi-Cone system works, including four illustrations which explain four different factors that insure maximum aeration and treatment. Also included are the results of two detailed studies of Hi-Cone installations. Both compare the Hi-Cone operation, efficiency and maintenance needs with that of diffused air plants.

Among the booklet's 16 photos, drawings, curves and tables, is a cross-section drawing which shows how all moving parts of the Hi-Cone system are above the liquid surface; thus permitting easy maintenance without emptying the tank.

Centrifugal Pumps

1027

Ingersoll-Rand, New York, N. Y., has just released a 16-page, 2-color bulletin featuring Ingersoll-Rand Class GT, **General-Purpose, Centrifugal Pumps.**

According to the bulletin, these pumps are built in six basic sizes, ranging in capacities from 100 to 3500 gpm, for pressure to 450 psi, heads to 1100 ft, and temperatures at 300°F. They are horizontally split to permit complete accessibility of all internal parts without disturbing the suction and discharge piping. The bulletin also incorporates cross-sectional drawings, installation views, selection charts and dimension tables.

Four-Cycle Engines

1028

Nordberg Manufacturing Co., Milwaukee, Wis., has just published a 16-page bulletin on their line of **Four-Cycle Diesel, Duafuel, and Spark Ignition Gas Engines.**

The bulletin describes these in-line 6 or 8 cylinder supercharged; supercharged and intercooled; and Supairthermal units. Separate data sheets give horsepower ratings, outline drawings of the engines, and all dimensions which are required for preliminary planning.

The Supairthermal system which gives Nordberg engines higher horsepower output without increasing peak temperatures is explained and a

schematic diagram illustrates the Supairthermal cycle of operation.

Photographs and an annotated cross-section view through a power cylinder clearly show the basic design and construction features. The various applications of these four-cycle engines are shown by numerous photographs of recent installations throughout the world.

Power For Protection

1029

Caterpillar Tractor Co., Peoria, Illinois, has published a booklet, **Power For Protection,** that discusses staying in operation when power fails or disaster strikes.

The booklet describes, through illustrations, and successful installations, how Caterpillar Diesel Electric Sets help maintain "business as usual" whenever emergency strikes. The complete line of Cat electric sets is listed with horsepower and kilowatt ratings in this color booklet.

Prestressed Concrete Sewage Treatment Tanks

1030

The Preload Company, Inc., New York, N. Y., has just published a bulletin on the use of prestressed concrete for the construction of **Sludge Digesters, Clarifiers, Flocculators and Thickeners.**

The bulletin presents a complete discussion on sewage tanks and covers and roofs for the different types of tanks. A line drawing illustrates a typical wall and dome section and a plan of lean concrete cover construction joints.

The back cover contains a list of recent Preload installations, giving the location of the installation, number of tanks, diameter, height and the capacity of each tank.

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the 245

Sparling is pleased to present its new *245* tachometer type Indicator-Totalizer—built especially for *Main-line duty*. The *245* is the result of 8 years of research and development work in Sparling's laboratory.

Its virtues? It is precise in measurement and it is built for the *rugged, long life required on the Main-lines.* Heavy duty, corrosion resistant materials are the guarantee of this statement!

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E. R. P. engineer inspects control panel for cathodic system protecting clarifiers at Louisville Water Co., Louisville, Ky.

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stops corrosion at lowest overall cost

Electro Rust-Proofing Cathodic Protection is used by the Louisville Water Company to prevent corrosion of metal underwater equipment in the raw water clarifiers.

Cathodic protection is the one method able to reduce corrosion of underwater metal virtually to zero. Electro Rust-Proofing Cathodic Systems are designed to provide the sole protection of submerged structures or to supplement a good protective coating. When used in conjunction with coatings, cathodic protection eliminates corrosion due to holidays or inherent breaks in coatings such as can occur at many inaccessible structural joints.

Electro Rust-Proofing designs every cathodic system individually so that maximum protection is given for the lowest operating cost. For information about E.R.P. Cathodic Protection, write for Bulletin #E-39.

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New W&T Solvay Chlorine Detector*

detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.

Write for Publication 50.118

WALLACE & TIERNAN INCORPORATED

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I-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

Chlorine-Handling Manual

1031

Fischer & Porter Co., Hatboro, Pa., has just issued a Technical Bulletin on the **Handling of Chlorine Liquid and Gas from Container to Dispenser.**

The booklet gives pertinent facts about chlorine, lists safety precautions, and outlines recommended practices for designing and constructing chlorine supply systems.

Welcome To Blaw-Knox

1032

Blaw-Knox Company, Pittsburgh, Pa., has recently published a booklet, **Welcome to Blaw-Knox,** that provides a quick but comprehensive look at the scope of the company's operations.

The booklet colorfully illustrates some of the products engineered and fabricated by Blaw-Knox for industrial applications in food and chemical processing, utilities, metallurgy and construction. Also listed in the booklet are the company's principal places of business.

All Transistor Amplifier

1033

The Systems Division of Beckman Instruments, Inc., Fullerton, Calif., now has available on request, a four-page brochure on the **Beckman All Transistor Amplifier.**

According to the brochure this unit is a high gain, broad band, chopper stabilized, precision amplifier specifically for use in analog computation and amplification for low level DC signals such as strain gage transducers or thermocouple output. High reliability over conventional amplifiers is due primarily to its being fully transitorized, light weight, cool, and free of microphonics, plus a built-in power supply that will accept inputs up to plus or minus 15 volts and has an output capability of plus or minus 15 volts at 100ma.

This brochure is very descriptive, utilizing complete diagrams, block diagrams and photographs explainiing operation, typical applications and operations specifications.

Things You Can Not Do!

"You can not strengthen the weak by weakening the strong. Nor, can you further the brotherhood of man by encouraging class hatred."—*Abraham Lincoln.*

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INDEX TO ADVERTISERS

A

*Alabama Pipe Co. 127A
Albright & Friel, Inc. 129A
Alvord, Burdick & Howson 129A
Aqua Survey & Instr. Co. 122A

B

Badger Meter Mfg. Co. 13A
Baffa, John J. 129A
Baker, Jr., Inc., Michael 129A
*Bethlehem Steel Corp. 30A
Betz Laboratories, Inc. 129A
*B-I-F Industries, Inc. 11A-51A
Black & Veatch 129A
Blackburn-Smith Mfg. Co. 118A
Bogart & Childs 129A
Bowe, Albertson & Associates 129A
Boyle Engineering 129A
Brockway, Weber & Brockway, Inc. 129A
Buck, Seifert and Jost 129A
*Builders-Providence, Inc. 11A-51A
Burgess & Niple 129A
Burns & McDonnell 129A
*Byron Jackson Co. 29A

C

Calgon Co. 8A
Camp, Dresser & McKee 129A
Capitol Engineering Corp. 129A
Cast Iron Pipe Research Ass'n. 36A-37A
Centric Clutch Co. 28A
Chapman Valve Mfg. Co. 39A
Chemical Equip. Co. 131A
*Chain Belt Co. 31A
Chester Engineers, The 129A
*Chicago Bridge & Iron Co. 17A
*Chicago Pump Co. 101A
Climax Engine Mfg. Co. 111A
*Clow & Sons, James B. 25A
Cole & Son, Chas. W. 129A
Colorado Fuel & Iron Corp. 121A
Consoer, Townsend & Associates 129A
Cotton, Pierce, Streander, Inc. 129A
Crane Co. 41A

D

Darley & Co., W. S. 123A
De Leuw, Cather & Co. 129A
De Zurik Corp. 45A
Dixie Tank & Bridge Co. 106A
*Dorr-Oliver, Inc. Inside Back Cover

E

Electrovert Ltd. 115A
Electro-Rust Proofing Corp. 128A

F

Fairbanks, Morse & Co. 42A
Fay, Spofford & Thorndike, Inc. 129A
Finkbeiner, Pettis & Strout 130A
*Fischer & Porter Co. 4A
Flexible Inc. 112A
Ford Meter Box Co. 124A
Foxboro Co. 48A
Freese, Nichols & Turner 130A

G

Gannett Fleming Corddry and Carpenter, Inc. 130A
Gilbert Associates, Inc. 130A
Glace & Glace 130A
*Graver Tank & Mfg. Co., Inc. 19A
*Graver Water Conditioning Co. 20A
Greeley & Hansen 130A

H

Hamilton-Kent Mfg. Co. 103A
Haskins, Riddle & Sharp 130A
Havens & Emerson 130A
Hayden, Harding & Buchanan, Inc. 130A
Hazen & Sawyer 130A
Healy-Ruff Co. 123A
Hersey Manufacturing Co. 27A
Henningson, Durham & Richardson 130A
*Hooker Electrochemical Co. 10A
Hydraulic Development Corp. 124A

I

*Infilco Inc. Back Cover
*International Mineral & Chemical Corp. 122A
*Iowa Valve Co. 35A

J

*Jeffrey Mfg. Co. 38A
Jennings-Lawrence Co., The 130A
Jones, Henry & Williams 130A

K

Keasbey & Mattison Co. 32A
Kennedy, Clyde C. 130A
Knowles, Inc., Morris 130A
*Komline-Sanderson Engineering Corp. 26A
Kuhns Bros. Co. 109A

L

Lanning Sanitary Engineering Co., Inc. 130A
Layne & Bowler 23A
Leopold & Co., F. B. 18A
*Link-Belt Co. 9A
Lockwood Greene Engineers, Inc. 130A
Lozier Co., Wm. S. 130A
*Ludlow Valve Mfg. Co. 49A

M

*M & H Valve & Fittings Co. 110A
Metcalf & Eddy 130A
Minneapolis-Honeywell Reg. Co. 24A
Mueller Company 21A-43A
Martell Co., J. W. 102A
Morton Salt Co. 113A
*Multiplex Mfg. Co. 120A

N

*National Clay Pipe Mfrs., Inc. 3A
*Neptune Meter Co. 52A
Nussbaumer, Clarke & Velzy, Inc. 130A

O

*Olin Mathieson Chem. Corp. 14A

P

*Pacific Flush Tank Company 15A
Parsons, Brickenhoff, Hall & McDonald 130A
Philadelphia Quartz Co. 120A
*Phipps & Bird, Inc. 123A
Photovolt Corp. 104A
*Pollard Co., Inc., Jos. G. 44A
Pirnie Engineers, Malcolm 130A
Pitometer Associates, Inc. 130A
Pittsburgh-Des Moines Steel Co. 22A
Portland Cement Ass'n. 16A
*Pratt Co., Henry 125A
*Presstite Keystone Engr. Products Co. 119A
Purcell, Lee T. 131A

R

*Rensselaer Valve Co. 49A
Riddick, Thomas M. 131A
Robert and Company Associates 131A
*Roberts Filter Mfg. Co. 123A
Rockwell Mfg. Co. 33A

S

Safety Gas Main Stopper Co., Inc. 122A
*Simplex Valve & Meter Co. 40A
Sirrine Company, J. E. 131A
Smith & Associates, Benjamin L. 131A
*Smith & Loveless Inc. 114A
*Smith Co., A. P. 46A
Smith Co., S. Morgan 50A
Sparling Meter Co., Inc. 127A
Spring Load Mfg. Corp. 118A
Standard Dry Wall Products, Inc. 126A
Stanley Engr. Co. 131A
Stilson & Associates, Alden E. 131A
Stuart Corp. 122A

T

Taylor & Co., W. S. 123A
Tennessee Corporation 127A

W

Weston & Sampson 131A
Westinghouse Electric Corp. 6A-7A
Whitman & Howard 131A
Whitman, Requardt & Associates 131A
Weinman Pump Mfg. Co. 104A
W K M Mfg. Co. (Div. ACF Industries) Inside Front Cover
Wood Co., R. D. 116A-117A
Woodward Iron Co. 34A
*Worthington Corp. 12A

Y

*Yeomans Bros. Co. 47A

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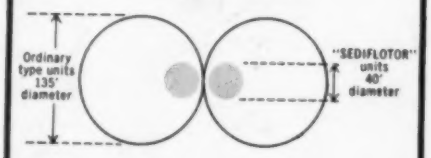

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